A prospective study on gait related intrinsic risk factors for patellofemoral pain

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Introduction

- Patellofemoral pain (PFP) is one of the most common disorders involving the knee in sportsmedicine.
- Incidence: 1 in 4 in the general population, even higher among athletes

PFP represents major problem in physically active populations such as adolescents, young adults, athletes and military personnel

Introduction

- Lack of consensus concerning aetiological mechanisms of PFP
- Numerous suggested risk factors : malalignement of the PF joint, soft periarticular imbalances, quadriceps muscle weakness, vasti muscle imbalance, bony abnormalities

→ Causes of patellofemoral pain are more multifactorial (Cheung et al., 2006)

Introduction

- Patellofemoral joint mechanics may be influenced by segmental interactions of the lower extremity (Powers, 2003)
- Abnormal lower extremity kinematics have been cited as a possible predisposing factor for PFP (Tiberio, 1987, Eng & Pierrynowski, 1993)
- Abnormal foot pronation such as excessive or prolonged pronation of the foot are propounded to be predisposing for PFP

Introduction

- No consensus in the literature concerning abnormal rearfoot pronation being a risk factor for the development of anterior knee pain.

→ Abnormal pronation not a universal finding in patients suffering from PFP

→ Care must be taken in attributing the cause of PFP symptoms to abnormal foot pronation

Introduction

- To date no studies have prospectively investigated relationship between rollover pattern of the foot and development of anterior knee pain.

- Purpose of this study was to prospectively determine gait related risk factors for PFP based on the plantar pressure distribution during gait

Materials and methods

- Subjects

84 officer cadets 65 men, 19 women	Mean ± SD
Age (years)	19 ± 1.5
Height (cm)	177.9 ± 7.8
Weight (kg)	67.5 ± 7.9

Materials and methods

Evaluation

- Rollover pattern of the recruits ‘s feet during gait were examined before the start of a 6 week basic military training period by means of plantar pressure measurements
- Footscan pressure plate (RsScan International)

Materials and methods

Plantar pressure measurements

- During walking (= major activity recruits performed during basic military training period)
- Footscan pressure plate (0.5m x 0.4m, 295Hz) embedded in the middle of a 15 m long walkway
- Walkway was covered by a thin rubber mat so the pressure plate was not visible to the subjects

Materials and methods

Plantar pressure measurements

- Subjects walked at a self chosen comfortable moderate velocity
- Three valid left and right stance phases were measured

Materials and methods

Data analysis

- For each trial the medial heel (H1), lateral heel (H2), metatarsal heads I to V and hallux (T1) of the feet were manually identified
- Temporal data (time to peak pressure, instants on which the regions made and ended contact), peak pressure data and absolute impulses (mean pressure x loaded contact time) were calculated for each region

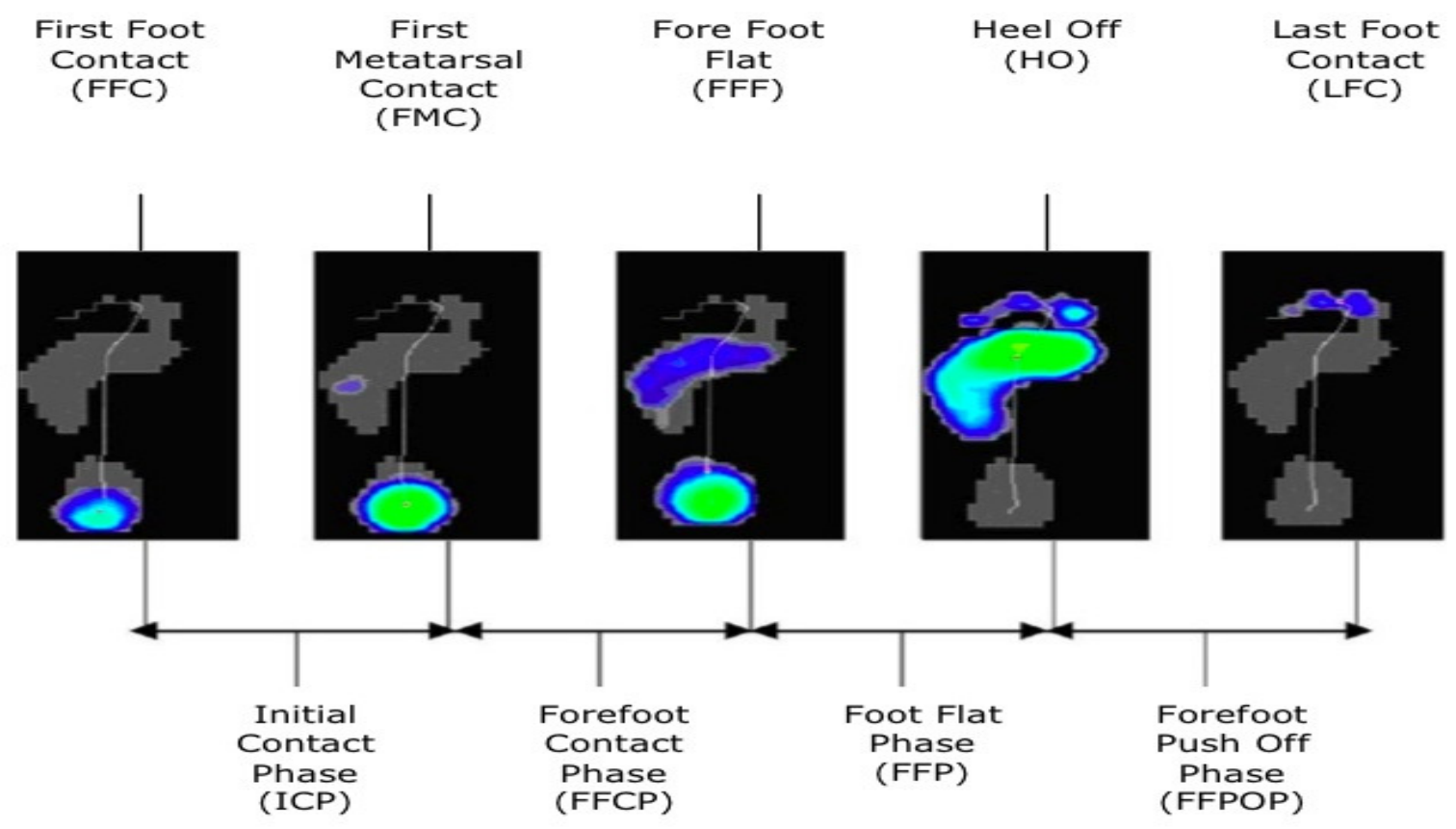
Materials and methods

Data analysis

- Total foot contact time and five distinct instants of foot rollover were determined for each trial:
  - First foot contact
  - First metatarsal contact
  - Forefoot flat
  - Heel off
  - Last foot contact

Materials and methods

Data analysis



(figure taken from Willems et al.)

Materials and methods

Data analysis

- Calculation of medio-lateral pressure ratio [(M1+M2+H1)/(M4+M5+H2)] (pressure distribution in the foot) at the five instants of foot contact and excursion ranges of ratio over the four phases
- Positioning of the Centre of Pressure (COP) and medio-lateral and anterior-posterior displacement of COP at the five instants and four phases of foot rollover

Materials and methods

Basic military training

- 6 weeks

- Marching (35%)
- Tactical exercices (25%)
- Drills (10%)
- Running (5%)
- Shooting (5%)
- Theoretical classes (20%)

Materials and methods

Registration of injuries

- Patellofemoral pain diagnosed and registered by a Sports Medicine Physician present at the training camp

- Sports Medicine Physician blinded to plantar pressure measurement results

Materials and methods

Registration of injuries

- Clinical criteria (De Haven et al., 1979, Kannus & Niitymaki, 1994, Witvrouw et al., 2000):
  - Pain on compression patella against femoral condyles (knee in full extension)
  - Tenderness of the posterior surface patella on palpation
  - Pain on resisted knee extension
  - Pain with isometric quadriceps contraction against suprapatellar resistance (in 15° knee flexion)

Materials and methods

Statistical analysis

- SPSS for windows (version 12.0)
- Binary logistic regression analysis
- Statistical significance at $\alpha \leq 0.05$

Results

	PFP group (n=36) Mean ± SD	Pain free group (n=48) Mean ± SD	P-value
tPmax M4	0.43 ± 0.08	0.46 ± 0.06	0.009
Ratio FFC	0.81 ± 0.24	0.90 ± 0.27	0.003
MAXvx FFCP	49.21 ± 29.74	79.50 ± 39.79	0.002

tPmax M4 = time (sec) to max pressure on the 4th metatarsal
Ratio FFC = medio-lateral pressure distribution at first foot contact
MAXvx FFCP = max velocity of medio-lateral displacement of the COP during the forefoot contact phase

Discussion

- Logistic regression revealed three gait related intrinsic factors as predicting factors for development of PFP:
  - A more laterally directed pressure distribution at FFC
  - Shortened time to max pressure on metatarsal 4
  - Delayed shift of the COP in latero-medial direction during FFCP

Discussion

- More laterally directed pressure distribution at FFC

→ Could indicate less foot pronation at FFC in PFP group

Duffey et al. (2000) found that runners with PFP had 25% less pronation during first 10% of support phase

Discussion

Adequate pronation of the foot is necessary to make an appropriate shock-absorption possible as the foot strikes the ground.

- Less pronation may cause a more rigid landing of the foot
- Increasing the impact on the lower extremity
- Contribute to overuse injury

Discussion

- Slower shift of the COP in latero-medial direction during the FFCP

→ In subjects who developed PFP more time was needed during FFCP to shift COP from the lateral side to the medial side of the foot

→ May suggest that persons who developed PFP roll over their foot more on the lateral side of the foot

Discussion

- More laterally oriented heel strike and rollover pattern of the foot

1) May cause less shock absorbtion in the foot

→ Greater part of ground reaction forces transferred to the knee

→ Higher load on the PF joint

→ Overload of the PF joint leading to PFP

Discussion

2) Less pronated position of the foot during the rollover pattern → less internal rotation of the tibia

→ Place tibial tuberosity in a more lateral position relative to the femur

→ Increasing Q-angle

→ A Larger Q-angle may cause increased lateral patellar tracking

→ Increased contact pressure on lateral facets of the patella

Discussion

- Results of this study contradict results of former studies (Areblad et al., 1990, Hamill et al., 1992, Eng & Pierrynowski, 1993, Callaghan et al., 1994, Cheung et al., 2006) which found an association between excessive foot pronation and anterior knee pain

- However ⟶ plausible that when normal physiological loading of the joint is exceeded by overuse, both, excessive as well as insufficient pronation of the foot may lead to PF dysfunction and cause PFP

Conclusion

- During gait the feet of the persons who developed PFP in the investigated population:
  - Had a heel strike in a less pronated position
  - Rollover more on the lateral side


Thank You