Influences of Muscle Fatigue of Unilateral Lower Extremity on Jump-Landing

Satoshi Imai
Yutaro Morishige
Ryoji Hayakawa,
Yasuo Niki
Masaya Nakamura
Kazuki Sato

Kengo Harato
Takeo Nagura
Shu Kobayashi
Morio Matsumoto
Toshibo Otani
Hideo Matsumoto

Institute for Integrated Sports Medicine, Rehabilitation Medicine, Orthopedic Surgery, Nursing and Medical care, Keio University
Satoshi Imai, PT

I have no financial conflicts to disclose.
Risk factors for non-contact ACL injury.

Anatomical & physiological risks:

Functional risks

Muscle fatigue

Functional asymmetry

Core, hip dysfunction

Proprioception, etc.

Environmental risks

Does muscle fatigue of unilateral leg induced the ACL injury?
We analyzed the Drop Vertical Jump before- and immediately after-fatigue protocol, and after taking rest for 2 min.

**Participants**
- Number: 23
- Gender: female
- Age: 20 ± 1 y/o
- Tegner Activity Score: 6

**DVJ**
- Drop height: 30 cm
- Platform height: 1/4 height
The fatigue protocol was that a subject performs repeated single leg stand-up from 30-cm high chair until she fails to continue to do it because of fatigue.
Differences in each parameter was analyzed using ANOVA with post hoc test.

- Parameters
  - Jumping height
  - Knee joint angles
  - Knee joint moments
  - Vertical GRF

8 cameras and 46 retroreflective markers (Oqus, Qualisys, Savedalen, SWEDEN)

Visual 3D software (C-Motion, USA)

Force platforms (Type AM6110, Bertec, Columbus, OH, USA)
In fatigue protocol, the number of stand-up exercise until fatigue was 45±25 repetitions.

Jumping height

![Bar chart showing jumping height before and after fatigue protocol and rest](chart.png)
Results - Fatigue side

vGRF and Extension mom. were significantly changed. (maximum)

Flexion angle  (at peak vGRF)

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Extension mom.  (within 40ms after IC)

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Results - Non-fatigue side

Flexion angle and Extension mom. were significantly changed.
(at initial contact) (within 40ms after initial contact)

Flexion angle (at peak vGRF)

Extension mom. (within 40ms after IC)

vGRF

B-F | A-F | A-R
2000 | 1500 | 1000
1000 | 500  | 200

vGRF (Nm/kg)

B-F | A-F | A-R
4 | 3 | 2
3 | 2 | 1

Extension mom. (maximum)

B-F | A-F | A-R
2 | 2 | 1
Results - summary

Fatigue side

After-fatigue protocol, vGRF was significantly decreased (819±263 N/kg) with respect to that before-fatigue protocol (1318±394N/kg). Maximum knee extension moment in fatigue side was also significantly decreased (1.47±0.50 N·m/kg) with respect to that before-fatigue protocol (2.06±0.60 N·m/kg).

After-taking rest, no significant difference was observed in fatigue side vGRF (896±268 N/kg) with respect to that immediately after-fatigue protocol. Flexion angles at initial contact were decreased after the rest.

Non- fatigue side

After-fatigue protocol, no significant differences were observed both in vGRF and in maximum knee extension moment. However, flexion angle at peak vGRF was significantly decrease (42.1±7.0 degree) with respect to that before-fatigue (47.1±4.9 degree), and knee extension moment within 40 ms from initial contact was significantly increased.

After-taking rest, flexion angles at initial contact were decreased after the rest.
It is obvious that the performance of the lower extremity is affected by fatigue. However, the noteworthy finding in this study is that the biomechanics of the non-fatigue side is also affected by fatigue of the contra-lateral side, such as decrease in flexion angle and increase in extension moment while landing.

**Fatigue side**
- Muscle fatigue
- Avoidance of weight bearing

**Non-fatigue side**
- Compensating support
  - “stiff landing”?
In addition, although the performance (jumping height) was recovered after having rest, changes in the biomechanics were still remained at the level after fatigue protocol. These biomechanical changes are thought to be the risk factors for ACL injury, and they can be useful information to understand the mechanism of contralateral side of ACL injury after the ACL reconstruction.
Conclusions

Muscle fatigue of unilateral lower extremity may induced sports injury, such as an ACL injury.

• Risks may be increased on contra-lateral side.
• Asymmetry does not fully recover after rest for 2 min.
• These findings may indicate the mechanism of contra-lateral side of ACL injury after the ACL reconstruction.

References


Thank you for reading !!
If you have an interesting, please send me an E-mail : imai@keio.jp