

Eccentric contraction-dominant exercise associated with misuse of the body affects onset of enthesopathy

Kaichi Ozone^{1,2}, Takanori Kokubun¹, Hiroyuki Hayashi¹, Takuma Kano¹, Yuichiro Oka¹, Naohiko Kaneura¹

¹ Saitama Prefectural University, Saitama, Japan, ² Matsuda Orthopedic Clinic, Saitama, Japan

Introduction

Osgood-Schlatter disease, Achilles tendon to bone attachment disease etc... → The common sites of occurrence are "Enthesis"



• Enthesis is the boundary between soft tissue and hard tissue. Therefore, it is easy to concentrate mechanical stress.
• Enthesis has a characteristic^{※4} layer structure for stress buffering.
• Mechanical stress becomes excessive, and when it exceeds the limit of buffering action, pathological change occurs.

※4 layer (1) Tendon (2) Uncalcified Fibrocartilage (UFC) (3) Calcified Fibrocartilage (CFC) (4) Bone

"Enthesopathy": The main cause is recognized as "Overuse".

Main Clinical Treatment for Enthesopathy

• Rest • Stretch • Restriction exercise

If the main onset factor is "Overuse" it should be completely healed.

But Not completely heal... Relapse with high probability. Why??

According to a previous study¹⁾...
"Many people with OSD suffer from eccentric contraction of the quadriceps muscle during kicking motion"



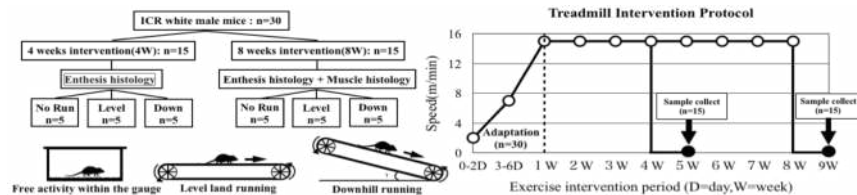
[Hypothesis] Eccentric contraction accompanying misuse of the body movement dominant exercise causes overuse of target muscles, and as a result influences the onset of Enthesopathy.

[Objective] From the experimental basic research using juvenile mouse, we will clarify how the mechanical stress accompanying different muscle contraction forms affect Enthesis structure.

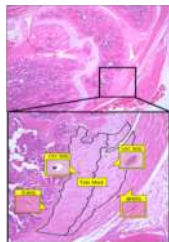
Methods

Subject : 30 male white ICR mice (4 weeks old) → Divided into two intervention groups (4W,8W)
→ Each intervention groups divide three groups (No run, Level, Down)

Target tissue : The supraspinatus (SSP) muscle & SSP attachment sites.



The contraction mode was changed by changing the running angle, which resulted in a change in the load amount (Level: Eccentric Contraction(EC) = Concentric Contraction(CC), Down: EC > CC)²⁾.



Rt ; Enthesis histology

- Sample collected
- Fixed (4% PFA) / Decalcified (10% EDTA)
- Embedded in paraffin, sectioned at 5 μm
- H&E, Toluidine-Blue, IHC staining (Primary antibody : Collagen type II)
- Calculate the area of fibrocartilage[FC] layer and UFC layer using Image J
- The ratio of the UFC layer to the FC layer was calculated
→ UFC rate = UFC / FC × 100[%]

※ Enthesis Statistical analysis: Shapiro-Wilk test → One Way ANOVA → Tukey method
※ Muscle Statistical analysis: Shapiro-Wilk test → Kruskal-Wallis test → Steel-Dwass method

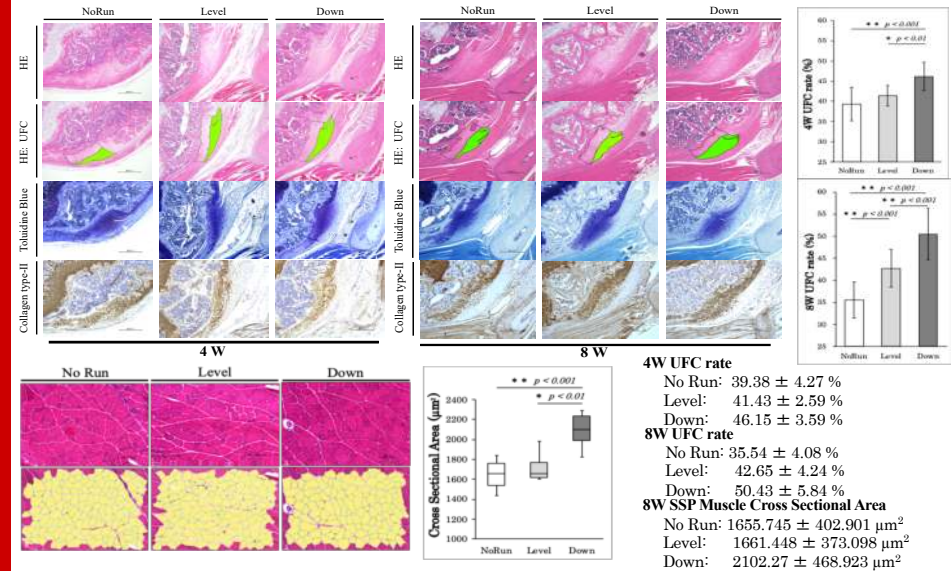
Lt ; Muscle histology

- Sample collected
- Using tragacanth gum fixed to cork, and quickly frozen at -100°C
- Sectioned at 10 μm
- H&E staining
- Measure total cross-sectional area of myofibers and number of muscle fibers
- The average cross-sectional area per muscle fiber was calculated

Reference

- 1) Fujii M et al. JUCSM (2014)
- 2) Armstrong RB et al. Appl Physiol(1983)
- 3) Sostolowsky LJ et al. J Shoulder Elbow Surg(2000)
- 4) Toigo M, Boutellier U. Eur J Appl Physiol (2006)
- 5) Wang X et al. J Clin Invest (2018)
- 6) Benjamin M, Raiphs JR. J Anat (1998)
- 7) Seki N et al. J Orthop Sci (2008)
- 8) Milz S et al. Adv Anat Embryol Cell Biol (2005)

Results & Discussion



In the Down group dominated by EC, expansion of the cross-sectional area and specific change of the UFC layer occurred.

Mechanical stress caused by EC is excessive compared to other contraction forms.

Excessive / Abnormal mechanical stress

- Muscle The cross sectional area increases³⁾. Muscle hypertrophy occurs by increasing the amount and size of actin myosin in muscle tissue and increasing the number of sarcomas⁴⁾.
- Enthesis Enthesopathy-like structural change occurs⁵⁾.

In this research a significant expansion of the UFC layer occurred...

- Regional factors : SSP Enthesis has a pulley structure⁶⁾. Therefore, compressive stress accompanying traction stress occurs on the inner surface of Enthesis⁷⁾.
- Compositional factor : A significant increase in proteoglycans present in UFC is confirmed by enhancement of compressive stress. In addition, it has been reported that tensile stress alone dose not result in formation of fibrocartilage⁸⁾.

EC dominant movement

Enthesopathy-like structural change

Enthesopathy is more likely to be caused by an increased rate of EC due to misuse of the body.

Conclusion

Continuous EC dominant exercise revealed that it may cause Enthesopathy-like structure changes while increasing the average muscle cross sectional area of the target muscle and showing the training effect. Over the years Enthesopathy has been thought to be caused by Overuse. However, since we newly proved that there is an influence due to the difference in muscle contraction mode, we believe that the results of this study can be important basic data for clarifying factors of Enthesopathy.

Acknowledgement

This study was approved by the university ethics committee and strictly adhered to the in-campus animal experiment guidelines (approval No. 28-7)

Contact

Kaichi Ozone

Master of Rehabilitation Science
(Saitama Prefectural University)

Mail: 1981304d@spu.ac.jp
<http://spubasic-lab.p2.welblife.me/index.html>

Conflict of Interest

No potential COI to disclose