Quantitative analysis of the gliding between subcutaneous tissue and vastus lateralis
– influence of the dense connective tissue of the myofascial–

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Introduction
It is reported that the thickness of connective tissue, including loose connective tissue (LCT), is associated with neck pain (A Stecco, 2013). However, the relationship between fascial thickness and gliding remains unclear. We decided to examine the association between muscular gliding and thickness of both myofascial and subcutaneous tissue (SCT).

Methods
Twenty-one limbs of 12 normal volunteers participated in this study. Ultrasonography (US) was performed using a Toshiba Medical Aplio500. Transducer was fixed on the lateral side of the thigh using original fixation device. Subjects were positioned lying on their side. Physical therapist moved the shank between 10 and 100 degrees of knee flexion with two constant rhythms (40 or 60 bpm) with the guidance of a metronome. Gliding of both the vastus lateralis (VL) and SCT occurred during this motion task. Based on dynamic US image, two regions of interest were placed on the VL and SCT. The present analytical method employed the successive abandonment method to determine relative movement between adjacent frames in sequences of US images (Library) (Figure 1). Flow velocity was arranged according to time series data. The gliding calculated a coefficient of correlation from each time series data-set. Total myofascia thickness, each LCT which was defined as the low echo layer in the myofascia, and dense connective tissue thickness (DCT) which was defined as the high echo layer in the myofascia, were measured using Image-J (NIH). And ratio of the LCT and DCT to the total myofascial thickness were measured as a LCT ratio, DCT ratio, respectively (Figure 2). Stepwise multiple regression analysis was also performed to analyze the predictors that influenced the gliding coefficient at two rhythms.

Results
At a 40-bpm rhythm, stepwise multiple regression analysis selected SC thickness and DCT
At a 60 bpm rhythm, stepwise multiple regression analysis selected SCT thickness and DCT ratio \((p< 0.05)\)

**Conclusion**

Increased thickness of the SCT led to increase tension of the skin ligament. Traction force which was generated by the skin ligaments transmitted to the VL through the myofasica of the VL. Therefore, Increased thickness of the DCT of the myofascia and SCT showed decreasing gliding between VL and SCT.

**Figure 1** Particle image velocimetry

![](image1.png)

(a) Based on an ultrasonogram moving image, two ROIs were placed on the VL and its superficial subcutaneous tissue

(b) Time series data of SC

(c) Time series data of the VL

**Figure 2** Tissues measurement of the thigh lateral part

1. Subcutaneous tissue thickness
2. Dense connective tissue thickness
3. Loose connective tissue thickness
4. 2+3: Total connective tissue thickness
5. 2/4: Dense connective tissues ratio
6. 3/4: Loose connective tissues ratio