Neuromuscular Characteristics Following Primary and Recurrent ACL Injuries

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Background

After anterior cruciate ligament (ACL) injuries the neuromuscular function at the knee joint is impaired.
Moreover, the risk of reinjury after ACL surgery is high, especially in patients who continue to participate in level I sports [3].
Causes of primary as well as recurrent non-contact injuries to the ACL are still poorly understood.

Aim

This investigation aimed at identifying motor unit characteristics in patients after primary and secondary ACL injuries and before reconstruction surgery.

Methods

30 male athletes with a median Tegner score of 7 (4-9) volunteered to participate:

10 primary ACL injury	Acl1: 26 (SD 7) years
10 secondary ACL injury	Acl2: 25 (SD 6) years
10 uninjured controls	Con: 25 (SD 4) years

Athletes were asked to perform an isometric knee extension at the injured side while muscle activity of the vastus medialis was captured non-invasively using a 5-pin sensor (Delsys, Natick, USA, Figure 1).

Force
- Maximum voluntary torque (MVT, $P<0.001$)
- Force steadiness (CV of torque, CVT, $P>0.9$)

The complex EMG signals were decomposed offline into individual motor unit action potential trains from different motor units (MUs).

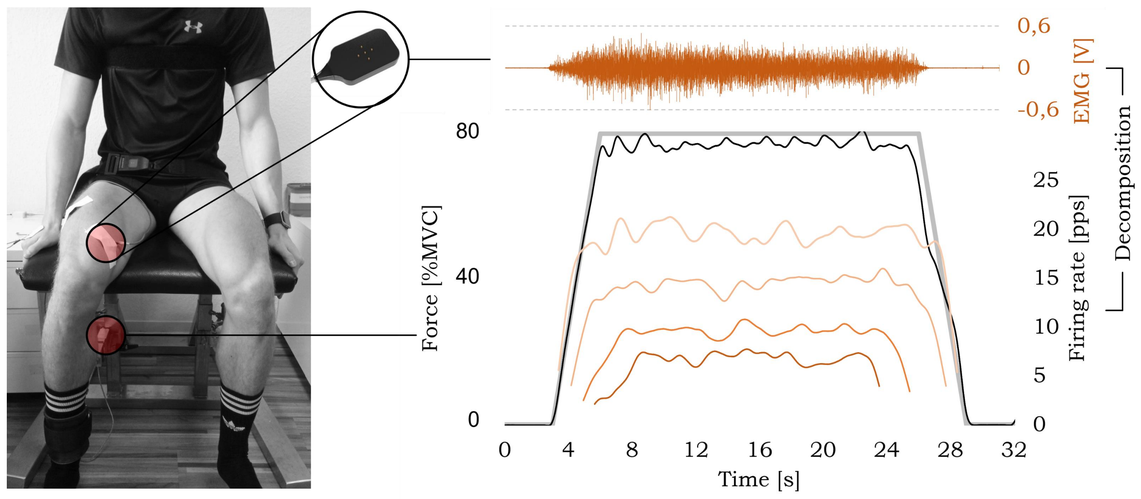

Figure 1. Study setup with signal decomposition (simplified).

Activation
- Recruitment threshold (RT) of MUs
- Mean firing rates (mFR) of MUs
- Action potential (AP) size
- Common drive (CD)

Associations
- RT and mFR (RR)
- CVT and RR
- CVT and CD

The RR represents contraction smoothness [1] while CD reflects the grade of simultaneous recruitment of the MUs [2].

Results

The mFR revealed large effects ($P<0.05$, $\eta_p^2>0.21$) with higher rates in both Acl1 (17.0 (3.8) pps) and Acl2 groups (16.6 (2.9) pps) compared with Con (13.6 (2.2) pps). The AP size showed large group effects ($P<0.05$, $\eta_p^2>0.22$) with lower amplitudes in both ACL groups (Acl1: 0.16 (0.06) mV, Acl2: 0.13 (0.09) mV) compared with Con (0.26 (0.16) mV).

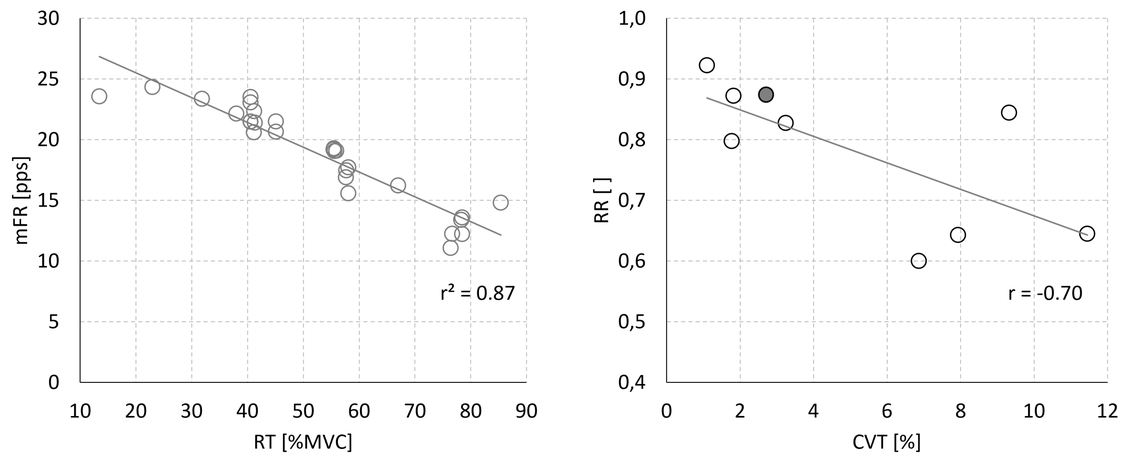

Figure 2. Relationship between mFR and RT for a single subject (left) and RR over CVT for the Acl1 group (right).

Both RR and CD were not affected by group ($P>0.5$, $\eta_p^2<0.05$). However, the CVT was significantly related with RR in Acl1 ($r=-0.70$, Figure 2) but with CD in Acl2 ($r=0.67$, $P<0.05$).

Conclusion

The strong associations of the degree of force steadiness with a smoother force production (Acl1) or with the degree of simultaneous MU recruitment (Acl2) indicate different compensatory mechanisms at the MU level.

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[3] Gokeler, A., Dingenen, B., & Hewett, T. E. (2022). Rehabilitation and return to sport testing after anterior cruciate ligament reconstruction. *Arthrosc Sports Med Rehabil, 4*(1), e77-e82.