P-53

Evaluating Precision in Muscle Quality Prediction Using Stimulated Muscle Contraction Signal

Mi-Jeong Yoon[1], Yerim Ji[2], Kwangsub Song[2], Sangui Choi[2], Hooman Lee[2], Ji Yoon Jung[1], Seungyup Song[3], Ilsoo Kim[4], Jaei Kim[4], Sun Im[3,*]

[1]Department of Rehabilitation Medicine, St. Vincent's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea
[2]Research and development, EXOSYSTEMS, Seongnam, 13449, Gyeonggi-do, Republic of Korea
[3]Department of Rehabilitation Medicine, Bucheon St Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Republic of Korea
[4]Biomechanics Research and Development Center, Rhin Rehabilitation Hospital, Yongin, Gyeonggi-do, Republic of Korea

Abstract **—The aim of this study was to assess the reliability of predicting muscle quality (MQ) by capturing stimulated muscle contraction signals (SMCS) in hemiplegic stroke patients. SMCS data were collected across three trials, alternating between examiners (A-B-A sequence) with 30-minute intervals for each subject. Both intra-rater and inter-rater reliability of MQ prediction exhibited coefficients of variation within 3% and interclass correlation coefficients exceeding 0.99. These results indicate that MQ prediction can be reliably measured in stroke patients.**

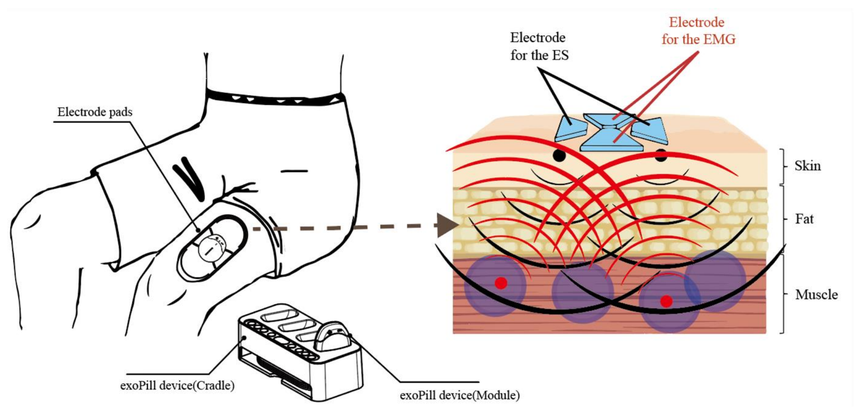
Keywords — Muscle quality, reliability analysis, surface electromyography, muscle stimulation

I. BACKGROUND

- Muscle quality (MQ) is a critical factor to evaluate in pathological conditions characterized by decreased muscle mass and strength. However, conventional assessment methods for MQ necessitate voluntary muscle contraction from the subject, posing challenges in accurately evaluating muscle condition, especially in the presence of motor impairment.
- To overcome these hurdles, surface electromyography signals, captured during muscle contraction induced by electrical stimulation—referred to as stimulated muscle contraction signals (SMCS)—can be employed to assess MQ.
- **This study aimed to validate the reliability of SMCS measurements using a wearable device, in hemiplegic stroke patients exhibiting motor impairment, investigating both affected and unaffected sides.**

II. METHODS

- The SMCS data were collected on both quadriceps femoris in three trials for 40 hemiplegic stroke patients, with **examiner changes following an A-B-A sequence at 30 min intervals.**
  - ○ Variations occurred, including alterations in examiners and disparities in electrode placement, throughout the three tests.



▲ The SMCS acquisition method using exoPill.

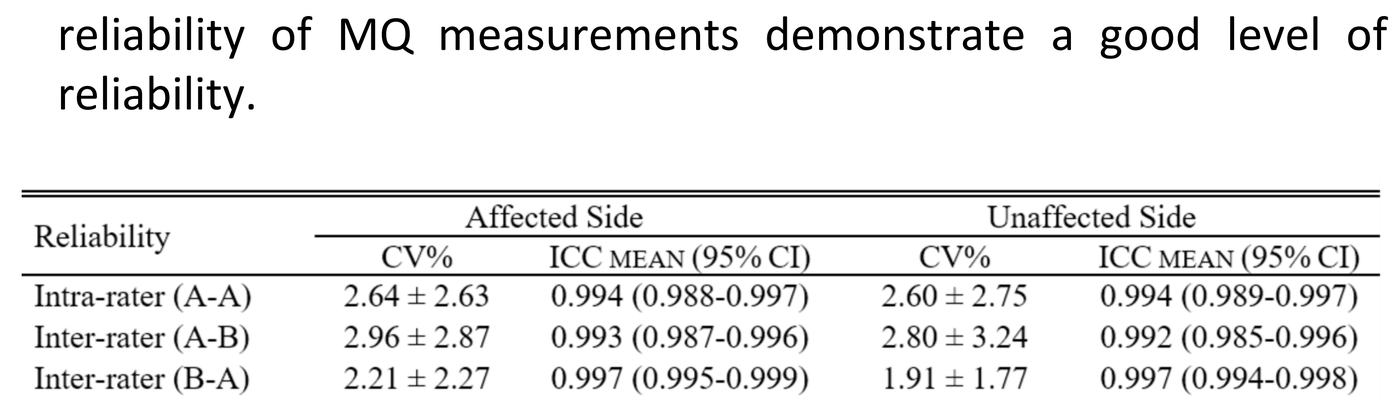
- For MQ prediction, feature extraction from SMCS was conducted in both the time and frequency domains. Finally, an ensemble regression model, constructed using a boosting method, was utilized.
- For reliability analysis, the coefficient of variation (CV) and the interclass correlation coefficient (ICC) were used to assess the MQ values predicted by the model.

III. RESULTS

- The CV values in repeated measurements by the same examiner (A-A) showed within **2.65%** for both affected and unaffected sides. Similarly, the repeated measurements by different examiners (A-B and B-A) also showed **no significant differences (p>0.05), with CV values ranging from 1.91% to 2.96%.**
- Additionally, the ICC values reflecting both intra- and inter reliability of MQ measurements demonstrate a good level of reliability.

Reliability	Affected Side		Unaffected Side	
	CV%	ICC MEAN (95% CI)	CV%	ICC MEAN (95% CI)
Intra-rater (A-A)	2.64 ± 2.63	0.994 (0.988-0.997)	2.60 ± 2.75	0.994 (0.989-0.997)
Inter-rater (A-B)	2.96 ± 2.87	0.993 (0.987-0.996)	2.80 ± 3.24	0.992 (0.985-0.996)
Inter-rater (B-A)	2.21 ± 2.27	0.997 (0.995-0.999)	1.91 ± 1.77	0.997 (0.994-0.998)
Inter-trial (A-B-A)	2.93 ± 2.25	-	2.74 ± 2.38	-

- Lastly, the CV for the entire three repeated measurements was **2.74%** for the unaffected side and **2.93%** for the affected side.



▲ The inter-trial reliability results (partial). The x-axis represents predicted MQ, and the y-axis represents actual muscle strength.

ACKNOWLEDGEMENT

This study was supported by the Technology Innovation Program (No. 20018182) funded by the Ministry of Trade, Industry & Energy (MOTIE, Korea).

IV. CONCLUSION

Our findings indicate the potential to use this novel technique reliably in assessing MQ for patients with motor deficits.