TIME-FREQUENCY ANALYSIS OF THE SURFACE ELECTROMYOGRAM USING WAVELET TRANSFORM ENABLES TO EVALUATE DYNAMIC ABDUCTOR MUSCLE PERFORMANCE IN THE PATIENTS WITH CHRONIC HIP DISEASES

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Introduction
The ultimate goal of treatment for hip diseases is to restore the joint function and to achieve good walking ability. Long lasting of hip disease suffering causes significant muscle atrophy, especially in type 2 muscle fiber (1). Good muscular recovery would be necessary after operative treatments, and qualitative and quantitative evaluation method for muscle recovery would be important to figure out the effective training methods or schedule. However, an accurate method for muscular performance during movement, which reflects the pathological change, was not available. Recently we reported that frequency analysis of the surface electromyogram (EMG) using wavelet transform enables to evaluate dynamic muscle performance (2) (Fig. 1). The purpose of this study was to investigate the relationship between the surface EMG analysis data of the abductor muscle using wavelet transform and the pathological characteristics of the muscle of the patient of chronic hip diseases.

Methods
Thirty-three patients (9 males and 24 females) who underwent surgery were investigated. The mean age at operation was 56±14.2 years old. Twenty-one patients had hip osteoarthritis, one had idopathic osteonecrosis of the femoral head, one had rapidly destructive coxarthrosis, and ten had aseptic loosening after THA. Type of the operation was THA in 15 patients, revision THA in 10, pelvic osteotomy in 3, femoral valgus osteotomy in 4, or femoral varus osteotomy in one. Before the operation, the dynamic EMG during a 10-m free walk was carried out. The electrode was placed on the belly of the medial gluteal muscle on the operative side, and a foot switch sensor was attached to the heel. The mean power frequency of the stance phase of the gait was calculated at 0.1-s intervals using wavelet transform, and the amount of change in the mean power frequency (MPF) before and after heel contact was calculated. The difference between minimum and maximum MPF was defined as MPF rising (MPFR) (Fig. 2). A biopsy specimen was taken from the belly of the medial gluteal muscle during surgery, and the muscle fiber type was classified using ATPase staining of the frozen sections. The diameter (the shortest one) and the area of type 1 or 2 fiber, and the ratio of type 1 or type 2 fibers and the fiber diameter (the shortest one) were measured using image processing software (NIH Image) to obtain the fiber composition ratio, i.e. etc., and the correlation with MPFR was examined.

Results
Type 1 fibers accounted for approximately 65% of the total, and this was significantly higher than the figure of 35% for type 2 fibers (p<0.01). The diameters of type 1 and type 2 fibers were 41.3±9.5 and 35.7±9.2µm, respectively, that of the latter being significantly smaller than that of the former (p<0.05). The proportion of type 2 fibers with a diameter of 30 µm or less was 34.2±24.1%, which was significantly higher than the figure of 35% for type 2 fibers (p<0.01). Type 1 fibers accounted for approximately 65% of the total, and this was significantly higher than the figure of 35% for type 2 fibers (p<0.01). The diameters of type 1 and type 2 fibers were 41.3±9.5 and 35.7±9.2µm, respectively, that of the latter being significantly smaller than that of the former (p<0.05). The proportion of type 2 fibers with a diameter of 30 µm or less was 34.2±24.1%, which was significantly higher than the figure of 35% for type 2 fibers (p<0.01). The mean age at operation was 56±14.2 years old. Twenty-one patients had hip osteoarthritis, one had idopathic osteonecrosis of the femoral head, one had rapidly destructive coxarthrosis, and ten had aseptic loosening after THA. Type of the operation was THA in 15 patients, revision THA in 10, pelvic osteotomy in 3, femoral valgus osteotomy in 4, or femoral varus osteotomy in one. Before the operation, the dynamic EMG during a 10-m free walk was carried out. The electrode was placed on the belly of the medial gluteal muscle on the operative side, and a foot switch sensor was attached to the heel. The mean power frequency of the stance phase of the gait was calculated at 0.1-s intervals using wavelet transform, and the amount of change in the mean power frequency (MPF) before and after heel contact was calculated. The difference between minimum and maximum MPF was defined as MPF rising (MPFR) (Fig. 2). A biopsy specimen was taken from the belly of the medial gluteal muscle during surgery, and the muscle fiber type was classified using ATPase staining of the frozen sections. The diameter (the shortest one) and the area of type 1 or 2 fiber, and the ratio of type 1 or type 2 fibers and the fiber diameter (the shortest one) were measured using image processing software (NIH Image) to obtain the fiber composition ratio, i.e. etc., and the correlation with MPFR was examined.

Discussion and conclusion
In general, high frequency wave of surface EMG reflects activity of type 2 fibers. Therefore, an increase of MPF during the early period of the stance phase indicates an involvement of type 2 fibers when the patient took a heel contact. Our study showed a significant relationship between MPFR and the average diameter or the ratio of the type 2 fibers from the abductor muscle. This indicates that the MPFR in surface EMG is a good indicator to evaluate functional muscle recovery in the postoperative training for the patients of chronie hip diseases.

Reference

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