

Results report

1. Title of Research and Development : Development of A Comprehensive System for Assessment of Sarcopenia, Osteoporosis and Joint Dysfunction
2. Principal Investigator : Masaki Takao (Associate Professor, Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Japan)
3. Counterpart Principal investigator : Guoyan Zheng (PrivatDozent, Institute for Surgical Technology and Biomechanics ,University of Bern (Switzerland))
4. Results of Research and Development:

This project aims to develop a comprehensive system to assess musculoskeletal conditions of high-risk elderly patients of mobility loss, fall and hip fracture by considering osteoporosis, sarcopenia and joint dysfunction simultaneously. Patients with hip arthritis or with femoral neck fracture have been recruited by the Japanese team. 2D X-ray images and 3D QCT of patients' hips have been acquired. The Japanese team managed to develop automatic system to extract 3D musculoskeletal models from the 3D data. The Swiss team has been developing a system for biomechanical hip modeling and for reconstructing 3D musculoskeletal models from 2D X-ray images.

In this fiscal year, Japanese team managed to develop statistical model of insertion of muscle fibers on the pelvic and femoral bones. The team consisted of a medical team from Osaka University and an engineering team from Nara Institute of Science and Technology. Last fiscal year, we had performed a preliminary cadaver study in Singapore to get the three dimensional data of muscle insertion using our original computer navigation system. We improved the computer navigation system and revised the experiment protocol. In January, 2016, we performed another cadaver study in Johns Hopkins University using 8 cadavers. We developed statistical atlas of muscle insertion area on the pelvic and femoral bones. We could not perform prospective clinical study to predict falls from 3D musculoskeletal model due to delay in developing automatic segmentation system of musculoskeletal models from 3D CT data. On the other hand, we performed a retrospective study to develop a large-scale database of 1142 patients with hip disorders including radiographs, 3D-CT data and operation data acquired using navigation system. The NAIST engineering team developed automatic matching system between 2D radiographs and 3D CT data of pelvic and femoral bones. Using the software, Osaka University medical team analyzed pelvic flexion in supine and standing positions in 474 patients.

Swiss engineering team of Bern University has succeeded in reconstruction of 3D pelvic model from 2D X-ray images using dataset from our database. By applying automatic planning system of total hip arthroplasty to their system, they succeeded in automatic cup implant planning based on 2D/3D radiographic pelvis reconstruction (Schumann S, 2015). In addition, they reported that they succeeded in reconstruction of muscle model of rectus femoris from 2D-Xray images.

On August 29th in 2015, we held mini symposium entitled "International Symposium on Musculoskeletal Simulation – from Big Data to Robot-assisted Rehabilitation" in Osaka University Nakanoshima center. We reported our achievements each other and discussed the future direction of combined research. This symposium was open and the number of participants was 32.

Reference: Schumann S, Sato Y, Nakanishi Y, Yokota F, Takao M, Sugano N, Zheng G. Cup Implant Planning Based on 2-D/3-D Radiographic Pelvis Reconstruction-First Clinical Results. IEEE Trans Biomed Eng. 2015 Nov;62(11):2665-73.