IN vivo 3 Dimensional Motion Analysis of the total elbow arthroplasty, using the x-ray fluoroscopic image

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Purpose
Total elbow arthroplasty (TEA) has obtained excellent results in the last decades. It is mainly used for the highly destructive arthritis caused by rheumatoid arthritis and ankylosis, non-union, established arthritis after trauma, and acute intra-articular comminuted fracture. Although TEA relieves pain and improves quality of life, it is fact that some implants require revision surgery. Probably one of the reasons is that in vivo 3 dimensional (3-D) movement of TEA has not become clear yet. Then we tried to do 3-D motion analysis of TEA, making use of 2-D/3-D registration technique we developed and had been used for 3-D motion analysis of the total knee replacement.

Materials and Methods
Seven elbows in five patients (one men and four women) with rheumatoid arthritis, who had undergone a total elbow arthroplasty with a non-linked Osaka University prosthesis (MMT) from 2000 to 2006, were enrolled in this study. Their ages at the time of the operation ranged from fifty-five to sixty-five (mean, sixty years). We could follow all these patients and the average time between the operation and the examination was 3 years.

We took continuous fluoroscopic lateral images of elbow joints treated with TEA during flexion. 3-D position and attitude of the TEA was analyzed from the 2-D projection image making use of 2-D/3-D registration technique, which superposes the CAD model of the humeral and the ulnar component in the silhouette of the TEA. (See the figure below.)

Results
The mean angle of extension was -45.2°±11.4° (-29.5°~ -57°), and that of flexion was 139.5°±6.9° (127.4°~144.1°). The ulnar component, vis-à-vis the humeral component, was first valgus position, and during flexion the valgus angle was gradually decreasing (Graph 1). On the other hand, pronation angle was gradually increasing (Graph 2). The mean change of the valgus angle was 15.1°±5.5°, and that of the rotation angle was 15.2°±7.8°.

The figures showed the 3-D dynamic image of four different views. They showed that the joint surface of each component was not congruent. It seemed that only the lateral edge of the ulnar component came into contact with the humeral component.

Discussion
Despite the increased longevity and the good results of total elbow arthroplasty, some have required a re-operation because of bushing wear, aseptic loosening, and instability. Some reports presumed the causes of these complications; too much constraint, abnormal ligamentous balance, malalignment or malrotation of implantation, or too much amount of activity. In this study, we were able to do the in vivo 3 dimensional analysis of the total elbow arthroplasty, making use of the 2-D/3-D registration technique which had been used for the analysis of the total knee arthroplasty. During flexion the amount of change of the valgus angle and the rotation angle varied. This was probably because of the malalignment and malrotation of implantation or the abnormal ligamentous balance. So analyses of more number of cases and analyses between the different prostheses (non-linked type or linked type), and the different surgical technique (to preserve the ulnar collateral ligament or not to preserve it) will be needed to clarify the causes of bushing wear, aseptic loosening, and instability.

References