Contouring anatomical plasty on the distal end of the humerus using a navigation system

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Introduction: There have been reports on the effectiveness of performing accurate orthopaedic surgery using navigation, but it has not yet been applied to operations in which bone is resected around the elbow joint. We have used a navigation system in performing elbow joint operation to confirm the morphology of the distal end of the humerus. The purpose of this study was to describe a method for positioning the frame of the reference markers and a registration technique for using a navigation system at the distal end of the humerus and also to show the usefulness of the navigation system as an effective tool for evaluating the bony contour for the bone resection.

Materials & Methods: In 10 cases of osteoarthritis of the elbow and deformity of the distal end of the humerus, anatomical plasty or bone resection was performed in order to restore anatomical morphology. Bone resections were performed on the distal end of the humerus using navigation, and on the proximal end of the ulna via freehand operation. All patients were followed up for more than two years after the operation. In order to compare the pre- and postoperative bone morphologies, the maximum heights and the areas of the bones projecting from the normal anatomical contour were measured from the CT images of the sagittal plane through the bottoms of the coronoid and olecranon fossae. The range of motion of the elbow joint, Mayo Elbow Performance Score (MEPS), and DASH score in the preoperative and the postoperative follow-up periods were compared in each case.

Results: In the coronoid and olecranon fossae, where navigation was used, the height of the remaining bone was significantly reduced and more accurately contoured, compared with the olecranon and coronoid processes of the distal ulna, where the resection was performed freehand without using navigation. The ranges of motion of the elbow joints were improved in all cases; in particular, elbow flexion was improved significantly from 107.8° to 127.7°. Significant improvements were obtained in the MEPS, from 76.5 to 98.5 points and in the DASH score, from 25.6 to 8.9 points. There were no complications due to the use of navigation, and elbow function was improved in all cases.

Discussion: In the anatomical plasty of bones to restore the normal bone morphology of the elbow joint, such as debridement arthroplasty, we considered that great reliance had to be placed on the surgeon's experience and spatial sense in order to accurately grasp the geometric relationships of the elbow joint, even when image intensification and radiographs are used during the operation. On the other hand, a navigation system can obtain real-time feedback on the bone morphology and real-time tracking of the surgical instruments. The goal of navigation-assisted surgery in the field of orthopedic surgery is to obtain maximal accuracy with minimal invasion. However, the greatest drawback of navigation-assisted surgery is the necessity of setting the frames of the reference markers on the bone and the surgical instruments. It is also troublesome to position the patient's arm and the surgical instrument so that the three-dimensional optical localizer can completely recognize their reference markers during the operation. Nevertheless, we concluded that the resection of bone at the distal end of the humerus using a navigation system was highly accurate and effective, compared with bone resection of the proximal end of the ulna performed freehand, and that navigation-assisted surgery is quite useful. In the future, in order to confirm its usefulness completely, it will be necessary to conduct prospective controlled studies of the cases in which arthroplasty is performed using navigation including the proximal end of the ulna.