

The three-dimensional visualization of the bony defect by the mirroring method based upon the contralateral bony geometry in total knee arthroplasty

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Introduction: When total knee arthroplasty (TKA) is indicated for the patients with a significant bony defect, it is important to evaluate its size and location precisely. However, it is occasionally difficult to recognize the defect on conventional plain-Xp. Thanks to the recent advances of radiological examinations such as computed tomography (CT), and magnetic resonance imaging (MRI), we are able to simulate the implantation prior to TKA as a preoperative 3D planning. There still exist some limitations to analyze the size, the detail 3D-geometry, and the relative position of the bony defect correctly, especillay in cases with surface alterations surrounding the defects in comparison with intact geometry of the knee. Here we tried to visualize the bony defect with our mirroring technique, which was the process to subtract the bone of affected side from an unaffected side bone model.

Materials & Methods: Eight patients (3 men, 5 women) with bony defects who underwent TKA comprising 3 patients with osteonecrosis, 2 patients with rheumatoid arthritis, 2 patients with pseudarthrosis after the bone fracture and 1 patient with Charcot's joint were enrolled in this study. Bony defects localized at the medial condyle of the tibia (n=4), the medial condyle of the femur (n=3), and the posteolateral condyle of the femur (n=1). Based on the CT data of bilateral lower extremities, we made a 3D bone CAD-model with the creating software (Mimics 14. 0) (Materialize). The bone model of the unaffected side was displaced symmetrically with reference to the sagittal plane to make a mirroring bone model using the imaging software (3-matics 6. 0) (Materialize). Then the mirroring bone model was fitted on the affected side bone, while we used the femoral head and the transepicomdylar line as a femoral reference. As for tibial side, the medial malleolus, the tibial tuberosity and the PCL enthesis were utilized as references. After we made a fine tune to correspond their form of condyles seemingly as much as possible, the affected bone model was subtracted from the mirroring bone image to visualize the bony defect as well as the alterations of the joint surface.

Results: As for the case of pseudarthrosis at the femoral posteolateral condyle, we could extract and visualize the bony defect as well as the geometrical change associated with it. In the case of osteonecrosis and Charcot's joint, we could depict the bony defect and the osteophyte clearly. While in the case of bilateral bony defect, such as the case of rheumatoid arthritis, this method could not be indicated due to its bilateral bony defects.

Discussion: We considered that the cases which contralateral limb kept nearly normal form, such as the case of osteonecrosis, Charcot's joint, and pseudarthrosis, were optimally indicative of our method. On the contrary, if there were bony defects bilaterally like in the case of rheumatoid arthritis, the result of subtracting an affected bone model from mirroring one was different from the actual one. Although the optimal threshold level of CT was still under investigation, this method was expected to be one of the new assessments to evaluate and to analyze the bony defect and its modification of the joint surface.