Joint preserving limb salvage surgery under navigation guidance

CHO HS[1], OH JH[1], KIM HS[2], HAN I[2], SHIN SH[2]

[1]*Department of Orthopedic Surgery, Seoul National University Bundang Hospital, Seongnam, Korea*
[2]*Department of Orthopedic Surgery, Seoul National University Hospital, Seoul, Korea*

mdchs111@snu.ac.kr

Introduction: Although the recent development of diagnostic modalities makes it possible to precisely resect bone tumors, most high-grade sarcomas involving the metaphyseal area require sacrificing the adjacent articular joint. The reconstruction of bone and joint defects may cause severe complications with long-term survival of sarcoma patients. There have been several reports on the preservation of the adjacent articular joint in the cases of skeletally immature patients with a sarcoma of the metaphysis. Fluoroscopy has been used in many orthopedic surgeries as a useful intraoperative guidance. However, it has some limitations in bone tumor surgery because of the difficulty in identifying the full extent of the lesion. Recently, the navigation system has been introduced for intraoperative guidance as an alternative to fluoroscopy. It can apply MRI and/or CT images to intraoperative visualization. This enables surgeons to intraoperatively identify the extent of tumors and to perform a more accurate surgery. When a tumor is located at the metaphysis, navigation-assisted surgery might be able to preserve the adjacent joint with a safe margin.

Materials & Methods: In the metaphyseal lesion, if the residual remaining epiphysis was expected to be more than 1 cm long after tumor resection with 1–2 cm of surgical margin and if preoperative chemotherapy was estimated to be effective by imaging studies, joint-preserving surgery was performed. Three patients underwent joint-preserving limb salvage surgery with the aid of the navigation system.

Preoperative preparation - Preoperative MRI was performed in the axial and coronal planes with T2-weighted STIR sequence, T1-weighted SE sequence and contrast-enhanced T1-weighted SE sequence. MRI was always performed before the fiducial placement. On the first preoperative day, three or four Kirschner wires, which were to be used as fiducials were placed under local anesthesia in the operating room. Kirschner wires should be placed beyond planned osteotomy sites to avoid tumor contamination. Multidetector row CT scans were obtained with the following protocol after wire placement: 120 kV, effective 10 mA with 0.5-sec rotation time, 20-mm scan collimation, 18.8-mm table feed per rotation and 1.3-mm reconstruction increment. To use CT and MRI data fusion images during navigation surgery, the image data of MRI (contrast-enhanced T1-weighted SE sequence) and CT were transferred to a workstation. MR images were re-sliced according to CT images using fusion software (Vworks 5.0, Cybermed, Seoul, Korea). The slice distances on the two images (CT image and resliced MR image) were equal because mutual information calculated them automatically. The fusion software carried out three-dimensional volume rendering and automatically performed the image-to-image registration between the CT images and the re-sliced MR images through mutual information algorithm. The CT-MRI fusion images were imported to the navigation system (In2Fusion, Cybermed, Seoul, Korea) for intraoperative guidance.

Operative procedure - A dynamic reference-base was fixed beyond the planned resection area. Patient-to-image registration was performed by paired-point registration using CT images and Kirschner wires which were placed preoperatively as fiducial markers. The registration error was