

The outcomes of computer-assisted bone tumor surgery: minimum 3-year follow-up

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Introduction: The usefulness and accuracy of computer-assisted surgery have been evaluated clinically in many orthopedic fields, such as, joint replacement arthroplasty, cruciate ligament reconstruction, and pedicle screw placement¹⁻³. Recently several preliminary reports have been issued on the application of navigation to bone tumor surgery⁴⁻⁷. It is expected that the technique allows preservation of function to be maximized by minimizing unnecessary resection and eventually it would be expected to lead to superior prognostic and functional results. We evaluated the oncological and functional outcomes patients whose malignant bone tumor was excised with assistance of navigation.

Materials & Methods: We reviewed the data on 18 patients who had been surgically treated with navigation-assistance from February 2005 for primary bone malignancy and followed up more than 3 years. Patients with the following criteria were considered eligible for navigational surgery: 1) primary bone malignancy in the metaphysis of long bone or in the pelvic ring including the sacrum, 2) skeletal maturity in case of metaphyseal malignancy, 3) absence of systemic metastasis, and 4) absence of skip lesion. With respect to metaphyseal lesion, if the residual remaining epiphysis was expected to be >1 cm long after tumor resection with a 1 to 2 cm surgical margin, and if preoperative chemotherapy was estimated to be effective by imaging studies, joint-preserving surgery was performed with navigation assistance. There were 11 men and 7 women with a mean age of 31.8 years. Tumor types included osteosarcoma, high grade chondrosarcoma, Ewing's sarcoma, and so on. The stage was IIB in all patients. There were ten pelvic ring surgeries and 8 joint-preserving limb salvage surgeries.

Results: The mean time for navigation set-up including reference base placement and registration was 28.9 minutes (range: 15 to 45 minutes). Mean registration error was 1.1 millimeters (range: 0.3 to 1.7 millimeters). Histological examination showed a clear resection margin in all patients and the distances from tumor to resection margin were in accord with preoperative plans in patients with a metaphyseal malignancy. The postoperative courses were uneventful in all patients. The overall three-year survival rate of the 18 patients was 88.9%. The 3-year survival rate of 10 patients with pelvic malignancy was 80.0% and that of 8 patients with metaphyseal malignancy was 100%. The event-free survival was 66.7%. Local recurrence occurred in two patients, all who had pelvic malignancy. Mean Musculoskeletal Tumor Society functional score was 26.9 points. According to anatomical location, the mean functional scores for 10 patients with a pelvic malignancy and 8 patients with a metaphyseal malignancy were 25.9 and 28.1 points, respectively. The active range-of-motion of the adjacent joint was not limited in all patients with metaphyseal malignancy except a patient who had an osteosarcoma in the distal femoral metaphysis. The patient had active knee ROM of 105 degrees. All patients with joint-preserving limb salvage surgery could walk without aid.

Conclusion: We suggest that navigation-assistance can be helpful during orthopaedic oncology surgery, because it can maximize the accuracy of surgical resection and minimize unnecessary sacrifice of innocent tissue by providing precise intraoperative three-dimensional radiological information. It eventually leads to improvement of oncological and functional outcomes. Nevertheless, its advantages in orthopaedic oncology need to be confirmed by further study in a large series of patients with a long-term follow-up.