Computer assisted surgery: applications in orthopedic oncology

GERBERS JG, JUTTE PC

Department of Orthopedic Surgery, University Medical Hospital Groningen, Groningen, The Netherlands
j.g.gerbers@umcg.nl

In our experience computer assisted surgery (CAS) can be applied to five types of surgeries in orthopedic oncology. These are excochleations of benign and low-grade malignant tumors, resections of small surface or intra-medulary bone tumors, segmental resections in larger/malignant tumors, reconstructing defects of resections and finally in the placement of tumor prostheses. Most of the above named types of surgeries require intra-operative imaging. All of them require control over resection margin both for recurrence prevention as to prevent unnecessary bone, and often functionality, loss. Since 2006 we have performed 130 oncological surgeries with CAS.

Most of these cases have been excochleations, 64, where CAS replaces fluoroscopy as an intra-operative imaging modality. Some of these patients have been treated with radio frequency ablation before surgery. All lesions were treated with phenol/ethanol, most reconstructions were done with PMMA. Advantages of CAS are real time three dimensional feedback, higher resolution and better quality image datasets and no use ionizing radiation. It is especially useful in larger lesions or lesions located in the femoral head or pelvis. Currently a study is being performed on patient satisfaction, recurrence and complications.

We performed an early analysis of patients with lesions above 5 cm in diameter or lesions located in a difficult anatomical location like the femoral head and pelvis. Average lesion diameter was 7.6 centimeters (range 2.9–16.1). Locations were humerus (2), femur (20), tibia (2) and pelvis (2). There were five lesions in the femoral head/neck and two in the humeral head. There were two pathological fractures and one fracture after adequate trauma.

Follow-up for the chondrosarcoma group of 21 lesions is 22.6 months (range 1-55), with 17 patients above one year of follow-up. In one cases there was a non-complete curettage. MRI follow-up showed residue along the border of the resection. Pathological examination after re-do showed vital chondrosarcoma. For the fibrous dysplasia group follow-up is 28 months (range 6–58). There were no recurrences in this group.

Another application where CAS has often been used is in resections and segmental resections (36 and 13). These can be preplanned before surgery, incorporating the margin required, and checked intra-operatively. Coloration of the tumor and of critical structures can be useful in avoid these structures. Sometimes it’s possible with careful planning to spare structures that otherwise probably would not confidently have spared. This use of CAS is especially clear in the cases where there were large resections in the pelvis. (6)

With hemicortical resection (6) it’s possible to use CAS to exactly copy the shape of the resected bone to an allograft. A CT scan of one case shows an average gap between host and graft of 0.9 mm (range 0-5.4) along the 6 cm resection. One interesting application is the combination of the shaped allograft with a vascularized tibia graft. In this combination the CAS created allograft, shaped like a horse shoe, surrounds the autograft, providing support and extra bonestock for fixation with plates.

Finally in 8 cases of imageless use in placement of tumor prostheses it feels greatly helpful in reconstructing the joint line, length and correct rotation.

There were 8 failures with the system or software. Setup time was measured in 47 cases and was on average 6:50 (range 2:26-14:27).
Indication and performance of CAS in orthopedic oncology is an under researched aspect of CAS. In our opinion CAS shows great promise in the field of orthopedic oncology and is a valuable tool in the operating room.