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Computer-Assisted Tumor Surgery (CATS) in Orthopaedic Oncology: How far have we come?

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Conventionally, tumor surgeons analyze two-dimensional imaging information and mentally integrate and formulate a three-dimensional surgical plan. It is difficult to translate the surgical plan to the operating room for complex cases with distorted surgical anatomy. Therefore, there is always a strong clinical need for better surgical aids to guide surgeons to achieve exactly what was planned for tumor free margin and bone reconstruction.

CATS has been recently applied in Orthopaedic Oncology and the technology may enable surgeons:
1) 3D based planning with multi-modal fused images (anatomical imaging: CT and MR and functional imaging: PET);
2) Exact correlation of imaging information to the real anatomical, pathological structures at the surgery under navigation guidance;
3) Image-guided bone resection as planned;
4) Accurate matching to prosthetic or allograft reconstruction.

Early results suggested that CATS is a safe option to accurately reproduce bone tumor resection as planned. The improved accuracy in executing surgical plans may offer clinical benefits in Orthopaedic Oncology. However, not every resection warrants the use of the technology and CATS may be more useful in technically demanding operations:
1) in pelvic or sacral tumors with difficult pathoanatomy
2) in hemicortical or joint-preserving tumor resection. More conservative resection is possible with the level of precision that does not compromise oncological principles. This allows patients to retain more native bone and joint for better function.
3) in prefabricated custom prosthetic or preparation of allograft reconstructions that are specifically designed to match a bone defect after a preoperatively planned resection.
Comparative studies with long-term follow-up are necessary to confirm its clinical efficacy.Future areas for CATS related studies include

Technology aspects:
- optimizing software system to allow a simple, friendly, all-in-one platform for preoperative 3D planning in orthopaedic oncology;
- the best image modality for image guided navigation surgery;
- the role of patient-specific tumor cutting guides and robotic-assisted system in executing surgical planning.

Clinical impact:
- the evaluation of surgical margin and its related oncological results;
- surgical practice at low-volume tumor centers;
- surgical training in Orthopaedic Oncology.

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