Title:
11161—Standardizing Bony Sarcoma Margin Documentation with Intraoperative Computer-Aided Navigation

Authors:
Stephanie E. W. Punt, BS stepunt@uw.edu, Jedediah K. White, BS jedwhite@uw.edu, Viviana Bompadre, PhD viviana.bompadre@seattlechildrens.org, Alissa Little, RN allissa.little@seattlechildrens.org, Ernest U. Conrad, III, MD chappie.conrad@seattlechildrens.org
University of Washington, Seattle, WA USA
Seattle Children's Hospital, Seattle, WA USA

Background: Documentation and achievement of appropriate surgical margins and reconstructions during oncologic procedures remain challenging in orthopaedic oncology.

Purpose:
The purpose of this study was to 1) establish a best practice surgical protocol for bony sarcoma surgical margin documentation ("tumor map"), 2) to validate this protocol by measuring the difference between planned "preoperative," actual "intraoperative," and "final" bony tumor resection and margins, and to 3) record reconstruction metrics for limb salvage reconstructive constructs.

Methods:
76 patients from 2010-2015 with an osseous sarcoma and with appropriate preoperative and postoperative imaging were evaluated for planned "preoperative" surgical tumor margins. A best practice surgical protocol was established, utilizing surgical navigation to assist with the documentation of planned "preoperative," actual "intraoperative" surgical and "final" post operative tumor margins. Pathology reports with histologic diagrams were reviewed to assess final surgical margins. In addition to surgical margins, osseous reconstruction metrics were recorded including length and rotation of femoral tumors and center of rotation and inclination of the acetabulum. Intraoperative surgical navigation operative time was reported; including "registration" (without CT scanning) and navigation measurement times. Final reports summarized results for only the femoral and pelvic resections.

Results:
Actual "intraoperative" resection margins compared to planned "preoperative" and "final" pathologic margins revealed mean variations of 6.3mm and 11.1mm (Tables I and II). Comparison of intraoperative bony resection length to both preoperative (planned) and final pathology had mean variations of 1.84mm and 1.14mm. Navigation registration time improved over the evaluation of 76 patients (mean 9.14 vs. 6.70 minutes). Coronal tumor resection "maps" were created to document the tumor location and surgical margins.

Conclusion:

An established navigation protocol assisted in confirming our preoperative plan, intraoperative plan, and improved the documentation of the final bony sarcoma margins and reconstruction metrics. The low variation between preoperative and intraoperative metrics illustrated minimal changes to the preoperative surgical planned resection. The intraoperative assessment of the closest surgical tumor margins had a variability/error rate of 11.1mm between margins assessed intraoperatively versus the final pathologic margin. Surgical navigation improved surgical margins, reconstruction documentation and improved tumor resection documentation.

Level of Evidence: III

Table I: Case Summary

Tumor Location	#	Age	Average Resection Length	Preoperative Margin (MRI)	Intraoperative Margin (Navigation)	Final Margin (Pathology)
Femur/Tibia	34	17.3(2-87(years	12.6(4.0-23.0)cm; 23 cases	Prox: 27.6(10-100)mm Distal: 11.1(0-20.5)mm	*Prox: 27.6(10-100)mm *Distal: 11.1(0-20.5)mm	Prox: 33.6(1-200)mm Distal: 15.9(0-30)mm
Pelvis	27	20.7(9-80) years	13.9(3.2-20.0)cm; 14 cases	Prox: 15.0(10-20)mm Distal: 13.9(10-25)mm	*Prox: 15.0(10-20)mm *Distal: 13.9(10-25)mm	Prox: 7.78(0-30)mm Distal: 18.7(0-59)mm
Other	15	20.2(12-48)years	14.2(10.2-20.0)cm; 6 cases	Prox:26.7(15.3-38)mm Distal: --	*Prox:26.7(15.3-38)mm *Distal: --	Prox: 26.7(0-65)mm Distal: 51.7(25-85)mm

*Intraoperative navigation margins are reflective of preoperative plan. Final Pathology margin is used to confirm.

Table II. Average Margin and Resection Length Variation Across Cases

	Preoperative to Intraoperative*	Intraoperative to Postoperative**
Resection Length (mm)	1.8(0-29.3)	1.1 (0-30)
Margin (mm)	6.3 (0.0-17.0)	11.1 (1.0-34.0)

*Preoperative and Intraoperative metrics based on surgeon's navigation plan

**Postoperative metrics based on pathology