

Intraoperative Indocyanine Green Fluorescence Angiography is Sensitive for Predicting Postoperative Wound Complications in Soft Tissue Sarcoma Surgery

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Introduction

Indocyanine green (ICG) angiography provides intraoperative assessment of tissue perfusion. This technology has been predictive of postoperative wound complications for several surgical specialties. It is currently unknown if this technology can successfully predict complications following sarcoma resection.

In this study we aimed to evaluate the sensitivity and specificity of ICG angiography in predicting postoperative wound complications following soft tissue sarcoma resection.

Methods

A prospective cohort study was begun at our institution on 10/2017. Patients who underwent soft-tissue sarcoma resection were included. Following standard tumor resection and wound closure, the skin was evaluated with ICG angiography prior to leaving the operating room. Areas of hypoperfusion were marked, and depending on the surgeon, either left in place or excised until only well-perfused tissue remained on subsequent scans. The final ICG scans were used for predicting complications.

Patients were followed postoperatively until the incision had healed in order to determine the sensitivity and specificity of intraoperative ICG angiography in predicting postoperative wound complications.

Wound complications were defined as wound dehiscence and infection.

For this analysis patients who only underwent a split thickness skin graft were excluded as skin grafts are avascular and rely on multiple variables for healing.

Patient Factor	Value
Age (SD)	60 (17)
Gender	15 M : 8 F
BMI (SD)	27.6 (6)
Laterality	12 L: 11R
Smoking	
Current	2 (9%)
Former	8 (35%)
No	13 (56%)
Steroid Use	1 (4%)
Diabetes	4 (17%)
PVD	4 (17%)
CAD	7 (30%)
Radiation	
Neoadjuvant	20 (87%)
Adjuvant	1 (4%)
Chemotherapy	
Neoadjuvant	3 (13%)
Adjuvant	5 (22%)
Location	
Upper Extremity	8 (35%)
Lower Extremity	15 (65%)
Superficial to fascia	7 (30%)
Deep to fascia	16 (70%)

Table I: Patient Demographics

Characteristic	Wound Complication (n= 8)	No Wound Complication (n= 15)	P-Value
Age >80	2	0	0.11
Male Gender	7	8	0.18
ASA 3 or greater	6	4	0.04
Active Smoking	0	2	0.16
Current Steroid use	0	1	>0.99
Diabetes	3	1	0.1
PVD	3	1	0.1
CAD	4	3	0.18
Neoadjuvant Radiation	8	12	0.53
Neoadjuvant			
Chemotherapy	1	2	>0.99
Pre-operative Albumin < 4.0	2	1	0.42
Location			0.02
Upper extremity			
tumor location	0	8	
Lower extremity			
tumor location	8	7	
Depth			0.18
Superficial to fascia	4	3	
Deep to fascia	4	12	
Closure			0.47
Primary closure	3	7	
Local Flap	3	5	
Incisional wound			
vacuum used	8	10	0.12
Tumor >5 cm in largest diameter	6	11	>0.99

Table II: Factors Associated with Wound Complications (ASA = American Society of Anesthesiology, PVD = peripheral vascular disease, CAD = coronary artery disease)

	Overall	Upper Extremity	Lower Extremity
Sensitivity	50%	0%	50%
Specificity	79%	57%	100%
Positive Predictive Value	50%	0%	100%
Negative Predictive Value	79%	100%	70%

Table IV: Predictive Power of Intraoperative Indocyanine Green Angiography (excludes split thickness skin grafts)

Results

23 patients were included in the study. After exclusion of patients who only underwent a split thickness skin graft, 20 patients were included in the sensitivity and specificity analysis. Patient demographics are listed in **Table I** while factors associated with postoperative wound complications are listed in **Table II**.

Eight patients (35%) developed postoperative wound complications; all had their tumor located in the proximal lower extremity. Two were related to split-thickness skin grafting and were excluded from ICG angiography sensitivity analysis.

Six patients (30%) were predicted to have wound complications based on the final ICG scans, three in the upper extremity and three in the lower extremity. No patients developed a postoperative wound complication in the upper extremity (0%) while six patients (46%) developed a complication in the lower extremity.

The accuracy of ICG angiography was dependent on anatomic location, with improved accuracy in the lower extremity. A Two x two tables is demonstrated in **Table III** with sensitivity and specificity listed in **Table IV**.

Conclusion

Indocyanine green angiography has a high negative predictive value, and a high positive predictive value in the lower extremity for predicting postoperative wound complications. This technology may be beneficial for identifying wounds at-risk so that surgeons can address these wounds intraoperatively in order to lower the post-operative wound complication rate.

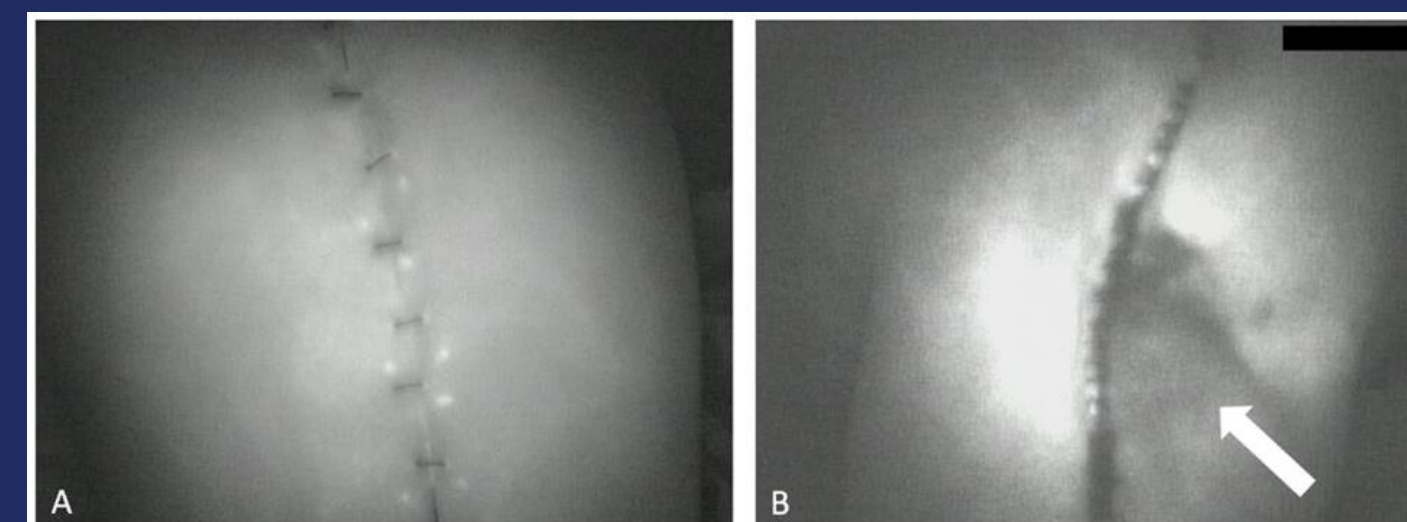


Figure 1: An example of a well-perfused lower extremity wound (A) and an upper extremity wound (B) that demonstrates a large area of hypo-vascular tissue adjacent to the incision (arrow). Both wounds healed without complications.

	Overall	
	Wound Complication	No Wound Complication
Predicted Wound Complication	3	3
Predicted No Complication	3	11

Table III: 2x2 Table for Overall Wound Complications