Predicting Post-Therapy Response Using Computational Image Analysis

Yan Wu[1,2]; Rebecca A. Moss[3]; Omar Hasan[2];
Pamela L. Kunz[4]; John L. Nosher[2]; David J. Foran[1,2]

[1]Center for Biomedical Imaging and Informatics, Rutgers
Cancer Institute of New Jersey
[2]Department of Radiology, Robert Wood Johnson Medical
School, Rutgers University
[3]Medical Oncology, Rutgers Cancer Institute of New Jersey
[4]Medical Oncology, Stanford University Medical Center

Background: Yttrium 90 radioembolization (Y90RE) is a
promising antiangiogenic therapy for neuroendocrine tumor
(NET) liver metastases, but responses are variable. In other
liver tumors, texture analysis of pre-therapy triphasic CT scans
has predictive power for response to Y90RE.

Methods: In this pilot study, 17 patients with NET liver
metastases were treated with Y90RE at Robert Wood Johnson
University Hospital, and images were collected as part of an
IRB-approved protocol. Tumor texture information was
extracted from the arterial and venous phase of baseline
triphasic CT images using the local binary pattern method
(LBP). A Support Vector Machine (SVM) model based on
baseline texture characteristics (LBP histograms) and other
features was used to predict whether a patient's time to
progression (TTP) would be longer than a preset threshold, and
predictions were compared with clinical outcomes.

Results: The median patient age was 64 (41-82). TTP (Figure
A) ranged from 100 days to 1521 days (12 patients); the
remaining 5 patients did not progress during the time of study
(>2000 days) or had complete response. To train the SVM, we
chose a TTP of 1095 days (3 years) to define a threshold for

differentiating responders from nonresponders. The SVM predicted TTP with 88% accuracy using arterial phase data. Adding tumor volume, gender, and patient age did not improve prediction accuracy. Triphasic data was significantly more accurate than venous phase data in identifying responders, which we independently confirmed using conventional contrast enhanced CT of 5 patients undergoing antiangiogenic therapy at Stanford Medical School in a set of parallel experiments.

Conclusion: SVM classification from arterial, but not venous, phase texture analysis shows promise in predicting post-therapy TTP for patients presenting with NET liver metastases. Prediction of treatment response by this method could provide decision support for recommending Y90RE on the basis of pretreatment triphasic CT.

(a) Patients' characteristics and TTP

| Patient	Tumor Volume	Gender	Age	TTP
1	430	M	70	100
2	314	M	41	376
3	929	M	74	1521
4	677	M	76	2000
5	236	M	52	314
6	459	M	64	2500
7	1218	F	57	331
8	1580	F	81	768
9	1164	F	81	763
10	745	M	45	1393
11	2252	M	53	2000
12	587	F	58	2000
13	280	F	82	474
14	1233	F	58	2000
15	308	M	65	129
16	1184	F	49	100
17	162	F	73	112
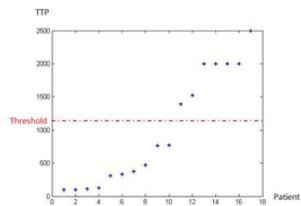
1095 days (3 years) was considered as the threshold to differentiate responders from nonresponders

(b) Texture analysis
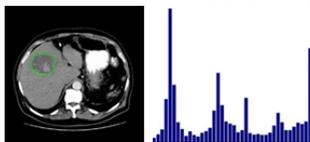
LBP Histogram of a Responder (with long TTP)
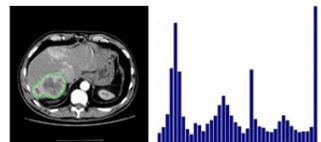
LBP Histogram of a Non-responder (with short TTP)

(c) Prediction on TTP using texture characteristics and additional features

	accuracy	sensitivity	specificity
texture	0.88235	1.0	0.71429
texture+tumor volume	0.82353	1.0	0.57143
texture+gender	0.82353	0.9	0.71429
texture+age	0.88235	1.0	0.71429