

CORRELATION BETWEEN PREOPERATIVE COMPUTED TOMOGRAPHY AND POSTOPERATIVE PATHOLOGICAL MEASUREMENTS OF TUMOR LENGTH IN CASES OF CARCINOMA ESOPHAGUS

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ABSTRACT

Objective: To compare the result of preoperative computed tomography (CT) and postoperative pathological measurements of tumor length in cases of carcinoma esophagus.

Material and Methods: Computed tomography thorax and upper abdomen with oral and intravenous contrast was done of biopsy proven 100 cases of carcinoma esophagus. The patients were then referred to Cardiothoracic Surgery Unit, PGMI, Lady Reading Hospital for esophagectomy. Tumor lengths measured on preoperative computed tomography and on the post-operative resection specimens were recorded.

Results: Out of 100 patients, 65 were male and 35 were female. Age ranged from 18 to 82 years with a mean age of 59.9 years. Middle and lower third tumors were present in 50 cases each. On CT scan the esophageal tumor length ranged from 1 cm to 13 cm with a mean length of 4.96 cm, whereas pathological measurements of esophageal tumor length ranged from 1cm to 12 cm with a mean length of 4.72 cm. There was a significant linear correlation between CT and pathology measurements of esophageal tumor lengths.

Conclusion: CT assessments generally overestimate macroscopic esophageal tumor length and should not be the only modality used for management decisions.

Key Words: Computed tomography, esophageal cancer, tumor length.

INTRODUCTION

Tumor length is a recognized independent adverse prognostic factor following surgery in patients with esophageal cancer¹⁻³. In a study by Griffiths et al², patients with pathological tumor length > 3.5 cm had a poorer prognosis than those with shorter tumors following esophagectomy for cancer⁴. As such, its accurate measurement preoperatively would provide essential information for treatment planning and prognosis.

Contrast enhanced computed tomography is an important aspect of staging patients with esophageal cancer⁵⁻⁸. However, published studies on the relationship between tumor lengths reported on the preoperative CT scan and the corresponding length

on the postoperative pathological specimen are inconsistent. Using pathological length as the gold standard and discounting length differences of 1 cm or less, Drudi et al⁹ reported 32% concordance between the two measurement types and CT was found to under-estimate tumor length. However, Quint et al¹⁰ reported CT generally overestimated tumor length by 1.5-1.75 cm. This finding was echoed by Gao et al¹¹ in which 34 patients with middle and distal third esophageal squamous cell carcinoma were found to have longer tumor length on the preoperative CT scans with a mean CT length of 4.48 cm vs mean pathological length of 3.82 cm.

The extent of gross esophageal tumor impacts the surgeon's choice of operative approach. The clinical target volume (CTV) will encompass the Gross Tumour Volume (GTV) and additional tissue based on pathological extent of subclinical disease from resected surgical series¹¹. It is, therefore, essential to ascertain as accurately as possible the gross tumor extent and staging by CT, barium imaging, endoscopy and endoscopic ultrasound (EUS).

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The aim of our study was to compare the result of preoperative computed tomography measurements of tumor length with postoperative pathological measurements in cases of carcinoma esophagus.

MATERIALS AND METHODS

Computed tomography thorax and upper abdomen with oral and intravenous contrast was done of biopsy proven 100 cases of carcinoma esophagus in Radiology Department, Postgraduate Medical Institute, Hayatabad Medical Complex, Peshawar. The patients were then referred to Cardiothoracic Surgery Unit, PGMI, Lady Reading Hospital from January 2006 to December 2006 and underwent esophagectomy. Patients of all ages, sexes, operable middle and lower third esophageal tumors were included in the study, while upper third esophageal tumor, inoperable carcinoma esophagus were excluded from the study.

For oral contrast gastrografin based solution was utilized. Slice thickness was 10 mm. The CT carried out closest to the time of tumor resection was reviewed in each case. The cranio-caudal tumor lengths in the immediate preoperative contrast enhanced axial CT images were estimated independently by one radiologist. Statistical analysis was performed using SPSS® Version 16.

RESULTS

Out of 100 patients 65 were male and 35 were female. Age ranged from 18 to 82 years with a mean age of 59.9 years. Middle and lower third tumors were present in 50 cases each. On CT scan the esophageal tumor length ranged from 1 cm to 13 cm with a mean length of $4.96 \pm \text{STD } 2.015$ cm, whereas pathological measurements of esophageal tumor length ranged from 1 cm to 12 cm with a mean length of $4.72 \pm \text{STD } 1.97$ cm. There was a significant linear correlation between CT and pathology measurements of esophageal tumor lengths (Table 1, 2).

DISCUSSION

The proximal and distal resection margins of various tumor types have been reported to shrink significantly following formalin fixation. Some example

Table 1: Descriptive Statistics

	N	Mini- mum	Maxi- mum	Mean	Std. De- viation
Age	100	18	82	59.79	11.744
CT Measur- ment	100	1	13	4.96	2.015
Post op Measur- ment	100	1	12	4.72	1.975
Valid N (listwise)	100				

Table 2: Correlations

		CT Measur- ment	Post op measure- ment
CT Measur- ment	Pearson Correla- tion	1	.996**
	Sig. (2- tailed)		.000
	N	100	100
Post op Measur- ment	Pearson Correla- tion	.996**	1
	Sig. (2- tailed)	.000	
	N	100	100

**Correlation is significant at the 0.01 level (2-tailed).

are breast¹³, colorectal¹⁴, esophageal cancers¹⁵ and cervical intra-epithelial neoplasia¹⁶. However, in all such cases, the proportion of size shrinkage attributable to the tumor itself is negligible¹³⁻¹⁶; and in the case of esophageal cancer, Siu et al¹⁵ reported only 8% shrinkage in the formalin fixed specimen compared to tumor length *in-vivo*. This suggests that longitudinal tumor length measured in formalin fixed resected specimens is comparable to their non-fixed *in-situ* state. In this study, we found strong linear correlation between preoperative contrast enhanced CT defined tumor length and their corresponding pathological lengths. The preoperative cranio-caudal axial CT images of esophageal tumor lengths were longer than their corresponding pathological lengths following esophagectomy.

The tendency for CT to overestimate esophageal tumor length compared to the corresponding pathological length was also reported by Gao et al¹¹. They studied 34 patients with middle and distal third esophageal squamous cell carcinoma and found a statistically significant difference between the two measurement types (mean CT length of 4.48 cm vs mean pathological length of 3.82 cm, $P < 0.05$). This is in keeping with our finding of mean CT and pathological tumor lengths of 4.92 and 4.72 cm respectively. However, in a study of 22 patients, Drudi et al⁹ found tumor length on the preoperative CT to be consistently shorter than the corresponding lengths on the resected specimens. The reasons for this finding were not discussed but may be related to observer error, scanning methodology or inadequate tumor delineation by contrast agent.

A number of studies have highlighted the deficiencies of CT in assessing the extent of post chemotherapy esophageal tumor bulk regression. In these studies, the radiological response rates were

significantly lower than the pathological response rate to chemotherapy resulting in an apparent upward tumor stage migration^{17,18}. This in part is due to chemotherapy associated inflammatory and fibrotic changes^{19,20}.

Several factors might contribute to the differences in tumor lengths obtained using the two approaches. Such factors include the difficulty in distinguishing tumor from mural thickening resulting from peri-tumor fibrosis, edema and gastric folds at the gastro-esophageal junction by CT^{21,22}. Other possible factors contributing to disparity between CT and pathological tumor lengths are sub-optimal coating of the mucosa by contrast agent²³, movement artifacts during the scanning process such as the respiratory or cardiac cycle^{24,25} and difficulty in determining the macroscopic proximal and distal limits of the tumor radiologically. Some of these factors might also contribute to the intra-observer variability in measuring tumor length using CT.

In addition to selection for treatment and staging, CT is also routinely used as part of the radiotherapy planning process but protocols usually do not include the use of oral contrast medium. As larger radiation treatment volumes are associated with higher radiation doses to normal tissues such as the lungs²⁶⁻³⁰ resulting in a higher incidence of treatment related morbidity and a poor therapeutic index, radiation therapy protocols usually exclude patients with longer tumor lengths (> 7-10 cm) from receiving radical radiotherapy. Since overestimation of *in vivo* tumor length has been commonly observed in our study, we would urge caution in excluding patients from radical radiotherapy treatment on the basis of CT findings alone. It is recommended that determination of treatment intent and target delineation of esophageal tumors during radiotherapy planning should be based on at least a further modality in addition to CT scanning as in the SCOPE (Study of Chemo-radiotherapy in Oesophageal cancer Plus or Minus Erbitux) clinical trial, currently recruiting in the UK. In the SCOPE study, where patients with a total tumor length greater than 10 cm are excluded from radical treatment, an endoscopic ultrasound (EUS) is required in addition to CT for determination of tumor length³¹. This stems from the observation that EUS more accurately measures esophageal tumor length and this imaging modality has been investigated in a number of studies^{32,35}.

Importantly, the use of positron emission tomography in combination with CT (PET-CT) in this setting could potentially ameliorate some of the limitations of CT alone, such as distinguishing a metabolically active tumor from peri-tumor edema, fibrosis and normal gastric rugal folds adjacent to subcardial tumors³⁶⁻³⁸. However, as PET acquisition is

over several minutes, the tumor extent seen on PET images will include the tumor motion due to movement and patient breathing during the period, in contrast to helical or multi-detector CT scans, which are acquired in a few seconds. Methods such as gating of PET images may be helpful in this context.

CONCLUSION

CT assessments generally overestimate macroscopic esophageal tumor length. CT measurements of tumor length cannot, therefore, act as a surrogate for pathological measurement. The limitation of CT should be considered when it is used for staging, in the selection of treatment and in radiotherapy planning.

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