

Long-Term Outcome After Resection of Non-Small Cell Lung Cancer Invading the Thoracic Inlet

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Background. The aim of this study was to update our previous experience and describe long-term results after resection of non-small-cell lung cancer (NSCLC) invading the thoracic inlet.

Methods. Patients from a single center undergoing resection of NSCLC invading the thoracic inlet were reviewed with data retrieved retrospectively from their charts.

Results. Sixty-five consecutive patients with a median age of 61 (32–76) years underwent resection of NSCLC invading the thoracic inlet from 1991 to 2011. Tumor location was divided into 5 anatomic zones from anterior to posterior. Fifty-two (80%) patients had induction therapy, mostly with 2 cycles of cisplatin-etoposide and 45 Gy of concurrent irradiation. All patients underwent at least first rib resection. Lobectomy was performed in 60 patients (92%). Twenty-four patients (37%) had vertebral resection. Arterial resections were performed in 7 patients (11%). Postoperative morbidity and mortality were 46%

and 6%, respectively. Pathologic response to induction was complete (pCR) ($n = 19$) or nearly complete (pNR) ($n = 12$) in 31 patients (48%). Adjuvant treatment was administered in 14 (25%) patients. After a median follow-up of 20 (0–193) months, 34 patients are alive without recurrence. The overall 5-year survival reached 69%. Univariate analysis identified site of tumor within the thoracic inlet ($p = 0.050$), response to induction ($p = 0.004$), and presence of adjuvant treatment ($p = 0.028$) as survival predictors.

Conclusions. Survival after resection of NSCLC invading the thoracic inlet in highly selected patients reached 69% at 5 years. Tumor location within the thoracic inlet, pathologic response to induction therapy, and adjuvant treatments were significant survival predictors.

(Ann Thorac Surg 2014;98:962–7)

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The thoracic inlet is the superior aperture of the thorax. It is delineated by the first thoracic vertebra (T1) posteriorly, the first rib laterally, and the manubrium anteriorly. Thoracic inlet tumors are defined by involvement of thoracic inlet anatomic structures on preoperative imaging and by the requirement of a first rib resection during the surgical procedure [1].

Tumors of the thoracic inlet are rare and account for less than 5% of all non-small-cell lung cancer (NSCLC) [2]. In an earlier study, we reported our experience with induction chemoradiation consisting of 2 cycles of cisplatin-etoposide and 45 Gy concurrent irradiation, followed by en bloc tumor resection in the setting of tumors located along the pulmonary sulcus and invading the spine [3]. In the present study, we focused on tumors

of the thoracic inlet, with their potentially challenging T1 vertebral resection, and update our previous report with longer follow-up as well as potential predictive factors for survival [1].

Patients and Methods

This was a retrospective single-center study including patients with NSCLC invading the thoracic inlet who underwent multimodality treatment including surgical resection. Data were retrieved from patients' electronic charts. The study was approved by the Institutional Research Ethics Board at University Health Network.

Preoperative tumor staging comprised computed tomography (CT) of the chest and abdomen, CT or magnetic resonance imaging (MRI) of the brain, bone scan, and integrated positron emission tomography with CT (PET/CT) after 2005. MRI of the spine/thoracic inlet was indicated in patients with suspicion of spinal invasion. Tumors were classified into zone 1 to 5 as described

Accepted for publication May 5, 2014.

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Abbreviations and Acronyms

CT	=	computed tomography
LOS	=	length of stay
MRI	=	magnetic resonance imaging
NSCLC	=	non-small cell lung cancer
pCR	=	pathologic complete response
PET/CT	=	integrated positron emission tomography with computed tomography
pNR	=	pathologic nearly complete response
pPR	=	pathologic partial response
R0	=	microscopic complete resection

elsewhere, according to the chest computed tomographic scan [4]. In case of tumor invasion into multiple zones, the zone with the most predominant involvement was chosen. Briefly, zone 1 (or the anterolateral zone) is located between the sternum and the anterior scalene muscle including the subclavian vein. Zone 2 (or anterocentral zone) is the area containing the subclavian artery, medial to zone 1. Zone 3 (or posterosuperior zone) is located between the subclavian artery and the T1 vertebra. Zone 4 (or posteroinferior zone) is situated below the posterior portion of the first rib toward the spine. Zone 5 (or inferolateral zone) is located below the

lateral portion of the first rib toward the distal subclavian artery (Fig 1).

The mediastinum was systematically assessed by cervical mediastinoscopy or endobronchial ultrasonographically guided fine-needle aspiration. Patients with mediastinal node involvement generally were not considered candidates for surgical intervention.

Induction treatment consisted mainly of 2 cycles of cisplatin-etoposide with concurrent 45 Gy irradiation to the primary tumor alone (25 daily fractions over 5 weeks). Restaging was performed with CT of the chest and abdomen and CT or MRI of the brain. MRI of the spine/thoracic inlet was performed if spinal involvement was suspected before induction. Patients without distant disease or local progression underwent surgical resection and compose the cohort of this study.

An anterior, posterior, or combined approach was selected by the surgeon according to tumor location and morphologic features, as described elsewhere [1]. All patients underwent resection of the first rib, per definition.

Tumors were classified and staged according to the seventh edition of the TNM classification of malignant tumors [5]. The relative amount of tumor necrosis after induction treatment was used to define response and was categorized as complete (100%), nearly complete ($\geq 95\%$), and partial ($< 95\%$) on final pathologic

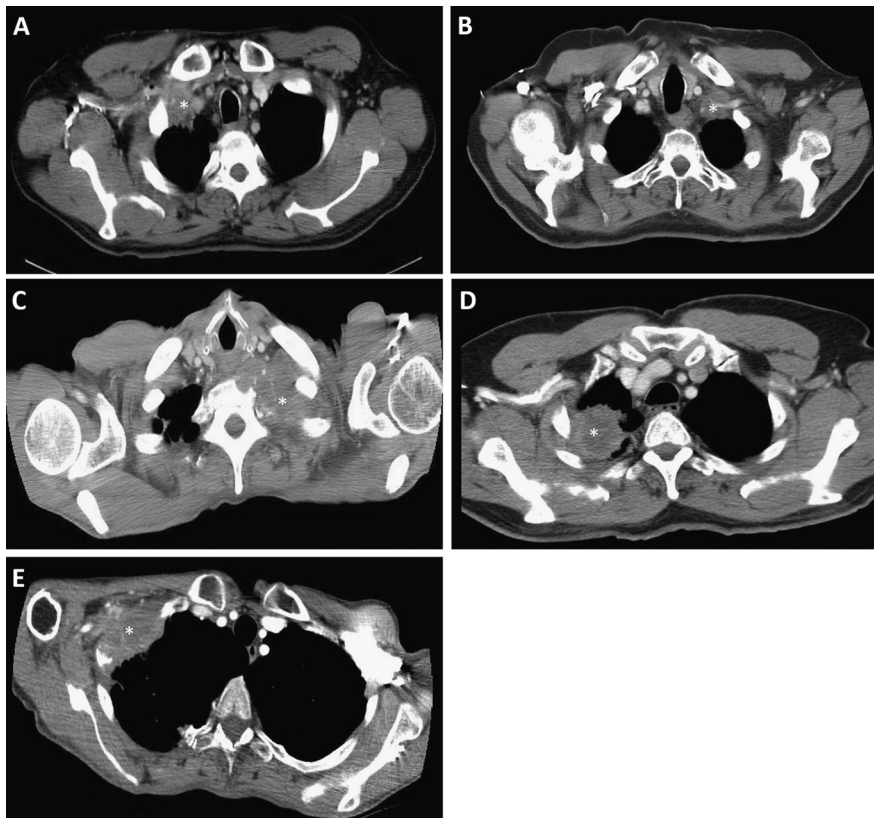


Fig 1. Computed tomographic images depicting tumor involvement of the 5 different zones of the thoracic inlet: (A) zone 1, (B) zone 2, (C) zone 3, (D) zone 4, and (E) zone 5. Tumors are indicated by asterisk.

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