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Original Article

Survival outcomes and prognostic factors in salvage surgery for advanced non-small cell lung cancer: a 10-year single-center experience

Ozgur Ozturk[1], Kenan Can Ceylan[2], Onur Akcay[1*], Seyda Ors Kaya[2], Ahmet Ucvet[2], Soner Gursoy[1], Aysen Evkan Ozturk[3], Ozgur Samancilar[4]

[1]Department of Thoracic Surgery, Bakırçay University Çiğli Training and Research Hospital, Izmir, Turkiye

[2]Department of Thoracic Surgery, University of Health Sciences, Dr. Suat Seren Chest Diseases and Chest Surgery Training and Research Hospital, Izmir, Turkiye

[3]Department of Intensive Care Unit, University of Health Sciences, Dr. Suat Seren Chest Diseases and Chest Surgery Training and Research Hospital, Izmir, Turkiye

[4]Department of Thoracic Surgery, Medicana International Izmir Hospital, Izmir, Turkiye

ABSTRACT

Background: In case of failure or a presence of residual tumor after definitive chemotherapy and/or radiotherapy applied in advanced lung cancer treatment, surgical treatment with R0 resection can be performed in selected patients. Also called salvage resections, the indications for these operations remain unclear in the literature. Our study investigated the efficacy of "Salvage" operations using postoperative survival, intraoperative–postoperative morbidity, and mortality along with prognostic factors.

Materials and Methods: Patients operated on for non-small cell lung cancer between January 2006 and December 2016 were examined. Among these patients, 51 patients who underwent R0 resection after definitive chemotherapy and/or radiotherapy were evaluated.

Results: The mean age was 57.58 ± 6.78 (46-78) years in 46 male and 5 female patients. Thirty-two (62.74%) patients had chemotherapy at the definitive dose, 16 (31.37%) received chemoradiotherapy, 3 (5.88%) underwent high-dose radiotherapy. The mean duration between treatment and surgery was 14 ± 10.89 (6-74) weeks. Thirty-two patients were clinically evaluated as Stage 3A, while 19 as Stage 3B and referred to definitive therapy. Thirty (63%) patients underwent lobectomy and 19 (37%) pneumonectomy. Forty-two patients (82.35%) had no complications, and there were complications in 9 (17.65%) patients. Postoperative mortality occurred in four (7.8%) patients. Five-year survival was calculated as 36.6%, and the median survival was 34 months. Median progression-free survival was 26.23 months.

Conclusion: "Salvage surgery" has been considered a feasible method in experienced centers with acceptable morbidity and mortality in selected patients with advanced lung cancer.

Keywords: definitive therapy, lung cancer, salvage surgery

Corresponding Author*: Onur Akcay, MD. Department of Thoracic Surgery, TC Sağlık Bakanlığı Bakırçay Üniversitesi Çiğli Eğitim ve Araştırma Hastanesi, Izmir, Turkiye.
Email: onur_akcay@yahoo.com Phone: +90 2323983700
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Introduction

Lung cancer, the most common malignity in men and the second most common in women, is a significant public health problem globally. Because effective screening methods are not sufficient and do not show specific symptoms, the cases are diagnosed as advanced stages at the time of diagnosis [1]. Salvage surgery refers to surgical resection performed after definitive non-surgical therapy (such as chemoradiotherapy) in patients previously deemed unresectable. Despite its increasing use, clear selection criteria and long-term outcomes remain controversial [2]. This study aimed to assess the survival outcomes and prognostic factors associated with salvage pulmonary resections in patients with advanced-stage NSCLC initially deemed inoperable.

Since approximately 70-85% of patients with non-small cell lung carcinoma (NSCLC) are diagnosed in the advanced stage at the time of diagnosis, most patients cannot have the chance for radical surgery [3]. Although systemic chemotherapy ± radiotherapy is generally recommended in this group, the 5-year survival rate is only 5-30% (4). In this group, salvage surgery performed due to local recurrences despite treatment, failure to respond to treatment, or the possibility of resectability after treatment may increase survival.

This retrospective study aimed to investigate the feasibility and efficacy of salvage surgery on survival (OS) with perioperative morbidity and mortality in NSCLC patients who were initially considered to be unable to undergo R0 resection, did not have distant metastases, and were referred to definitive chemotherapy / radiotherapy (RT) / chemoradiotherapy (CRT) for these reasons and subsequently operated. We hypothesized that salvage surgery could offer a survival benefit, particularly in patients achieving mediastinal downstaging after definitive therapy.

Materials and Methods

TBetween January 2006 and December 2016, 3500 patients were operated on for non-small cell lung cancer in our center. Among these patients, there were 80 patients who were initially evaluated as inoperable, referred for definitive treatment, and then referred for surgery again. Of these 80 patients, 51 patients who underwent standard lung resection and mediastinal lymph node dissection and who were considered to have R0 resection were included. Excluding criteria are; distant metastasis, incomplete resection and neoadjuvant therapy.

In the preoperative evaluation process of all patients, chest computerized tomography (CT) angiography, which did not exceed 30 days until the operation, positron emission tomography- computerized tomography (PET-CT), contrast-enhanced brain CT or magnetic resonance imaging (MRI), pulmonary function test (PFT), and blood gas examinations were performed after definitive treatment. The patients with borderline PFT values for resection underwent ladder and VO2max tests. A preoperative cardiological evaluation was performed on all patients. In the presence of suspicious mediastinal lymph nodes on chest CT and PET-CT, mediastinal evaluations were made with endobronchial ultrasound (EBUS) before the operation of the patients who had definitive treatment. The patients were followed up through the outpatient clinic during the postoperative period, and their latest status was updated via the central civil registration system. The effects of variables such as age, gender, type of definitive treatment, type of resection, pathological subtype, tumor diameter, and stage on 5-year survival were investigated. This study was conducted as part of a medical specialty thesis and was approved by the Training Commission for Medical Specialization of the University of Health Sciences, Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital. As per national regulations applicable at the time and the institutional protocol, a separate ethical committee approval was not required for retrospective analyses of anonymized data.

Statistical Analysis

For the analysis of quantitative data, compliance with normal distribution was examined by Kolmogorov-Smirnov Test, parametric methods were used in the analysis of variables with normal distribution and homogeneous variances, and non-parametric methods were used in the analysis of variables that did not have a normal distribution and homogeneous variance. Statistical Package for the Social Sciences (SPSS) 16 program analyzed the data. Comparisons were performed using the independent-samples t-test or Mann–Whitney U test for continuous variables, and Chi-square test for categorical variables. Survival was estimated using the Kaplan-Mei-

er method. Cox regression analysis was used for multivariable survival analysis. A p-value <0.05 was considered significant. Quantitative data were expressed in the tables as mean ± std. (standard deviation) and median ± IQR values. Categorical data were stated as n (numbers) and percentages (%). The data were analyzed at a 95% confidence level, and a p-value less than 0.05 was considered statistically significant.

Results

Of the patients in our study group, 46 (90.19%) were male, 5 (9.81%) were female, and the mean age was 57.58 ± 6.78 years (46-78). Twenty-five (49.01%) patients were not operated on and directed to definitive treatment due to mediastinal invasion, 24 (47.05%) due to bulky/multi N2, 1 (1.96%) due to widespread chest wall invasion, and 1 (1.96%) due to medical inoperability. 32 patients (62.74%) received CT, 16 (31.38%) CRT, and 3 (5.88%) radiotherapy. Before definitive treatment, the stages after clinical evaluation were determined as Stage 3A in 21 (41.18%) and Stage 3B in 30 (58.82%) patients.

The time from the last definitive treatment to the operation was calculated as 14 ± 10.89 (6-74) weeks on average. In the preoperative evaluation, 30 (58.82%) patients had no comorbid disease, while 21 (41.18%) patients had an accompanying disease. 32 (63%) patients underwent lobectomy, and 19 (37%) patients had pneumonectomy. Extended resection was performed in 14 (27.45%) of the patients. Mediastinal staging of 17 patients before definitive treatment or before surgery was evaluated either with EBUS or mediastinoscopy. Clinical evaluation was performed with PET-CT in other patients.

The mean postoperative hospital stay was 8.23 ± 3.12 (4-20) days. Postoperative complications developed in 9 (17.65%) patients. When the pathology reports were examined, 15 (29.41%) patients had adenocarcinoma, 28 (54.9%) had squamous cell carcinoma, and 8 (15.69%) had other pathological types. This other pathological subtype group included adenoid cystic carcinoma in 1 patient, NSCLC in 4 patients, large cell carcinoma in 1 patient, carcinoid tumor in 1 patient, and pleomorphic carcinoma in 1 patient.

The postoperative staging was evaluated as pTNM (pathological TNM) staging after multimodal treatments, and 11 patients (21.57%) were Stage 0, 17 patients (33.33%) Stage 1, 14 (27.25%) Stage 2, and 9 (17.65%) Stage 3.

The mean postoperative hospital stay was 8.23 ± 3.12 (4-20) days. 4 (7.8%) patients developed postoperative mortality in the first month. While no recurrence or metastasis was observed in 29 patients during their follow-up, 14 of 22 patients had lung recurrence, 4 had brain metastasis, one patient had liver, two had bone, and one had adrenal metastases. Five-year survival was 36.6%, and median survival was 34 months.

While the 5-year survival rate was 38.2%, and the median survival was 28 months in those with clinical stage 3A before definitive treatment, these values were 34.1% and 34 months in those with 3B, respectively (Figure 1). There was no significant difference between stage 3A and 3B patients (p = 0.505). The 5-year survival rate was 40.4% in patients with mediastinal invasion as the definitive cause of treatment, and it was 35.3% in patients with multi/bulky N2 (Figure 2). No statistical significance was observed between them (p = 0.254).

While the 5-year survival rate was 38.2% in patients who underwent lobectomy, it was 31.6% in pneumonectomy patients. Although the results were better in lobectomy, there was no statistical significance (p = 0.427). Considering the cell type, 5-year survival was 22.9% in adenocarcinoma, 40.7% in the squamous cell, and 46.9% in other pathologies. No statistical significance was observed between the pathology subtypes as well (p = 0.325).

The pathological T stage was evaluated, and the 5-year survival in the Tx group, which had a complete response after definitive treatment, was found to be the best at a rate of 54.5%. While it was 28.6% in T1, 42.4% in T2, and 40.8% in T3, no patient achieved 5-year survival in the T4 stage. There was no statistical significance between the values (p = 0.104). When the N status was evaluated, the 5-year survival rate was 49.1% in patients with N0 pathologically, 14.3% in N1, and 0% in N2 (Figure 3). Statistically, the survival rate was higher in N0 patients (p = 0.006). When the time to surgery after definitive treatment was examined, there was an inverse correlation between survival and time according to Pearson's correlation test, which was statistically significant (p = 0.032). R-value was -0.301.

Table 1. Studies on "salvage surgery" in the literature.

Authors	Years	No of patients	Indication	Timing of surgery (Weeks)	Mortality (%)	Follow-up (Months)	Overall of survival (Months)
Yang et al [14]	2015	31	RT+recurrent or persistant tumor	18 (8-111)	0	n.g	32
Uramoto et al [16]	2014	8	Mixed	n.g	0	14	n.g
Dickhoff et al [17]	2016	15	CRT+ recurrent or persistant tumor	21 (3-95)	6,7	12,1	46
Schreiner et al [18]	2016	9	CRT+ recurrent tumor	30 (12-165)	11	30	23
Verstegen et al [19]	2016	9	SBRT+ recurrent or persistant tumor	n.g	0	19	26
Shimada et al [20]	2016	18	CRT+ recurrent or persistant tumor	38 (3-282)	0	47	n.g
Mizobuchi et al [21]	2016	12	RT+ recurrent or persistant tumor	96 (36-312)	0	18	n.g
Our study	2020	51	CRT+ recurrent or persistant tumor	14 (6–74)	7.8	n.g	n.g

Abbrev.: n.g: not given; RT: radiotherapy; CRT: chemoradiotherapy; SBRT: stereotactic body radiotherapy.

Table 2. Patients who underwent extended resection.

	Age	Treatment	Type of resection	Follow-up time (Month)
Patient 1	69	Chemotherapy	Extended intrapericardial left pneumonectomy	40
Patient 2	58	Chemotherapy	Extended intrapericardial left pneumonectomy	102
Patient 3	56	Chemoradiotherapy	Extended right upper lobectomy with pulmonary arterioplasty	56
Patient 4	46	Chemoradiotherapy	Extended intrapericardial right pneumonectomy	2
Patient 5	58	Chemotherapy	Extended intrapericardial left pneumonectomy	27
Patient 6	59	Chemotherapy	Extended intrapericardial right upper lobectomy with bronchoplasty	28
Patient 7	51	Radiotherapy	Extended right lower lobectomy with pulmonary arterioplasty	4
Patient 8	63	Chemotherapy	Extended intrapericardial right pneumonectomy	9
Patient 9	48	Chemotherapy	Extended intrapericardial right pneumonectomy	108
Patient 10	68	Chemotherapy	Extended left upper lobectomy with pulmonary arterioplasty	76
Patient 11	59	Chemotherapy	Extended intrapericardial left pneumonectomy	88
Patient 12	63	Chemotherapy	Extended right upper sleeve lobectomy	85
Patient 13	63	Chemotherapy	Extended left upper lobectomy with pulmonary arterioplasty	1
Patient 14	55	Chemotherapy	Extended intrapericardial left pneumonectomy	13

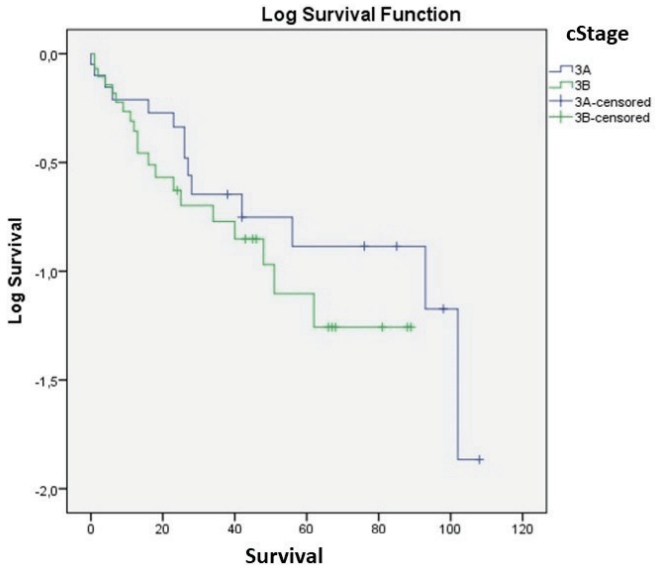

Figure 1. Survival in stages 3A and 3B before definitive treatment.

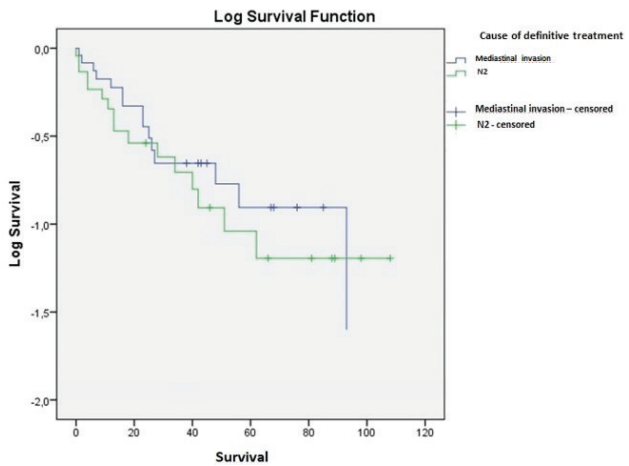

Figure 2. Survival in patients with definitive treatment for mediastinal invasion or bulky/multi N2.

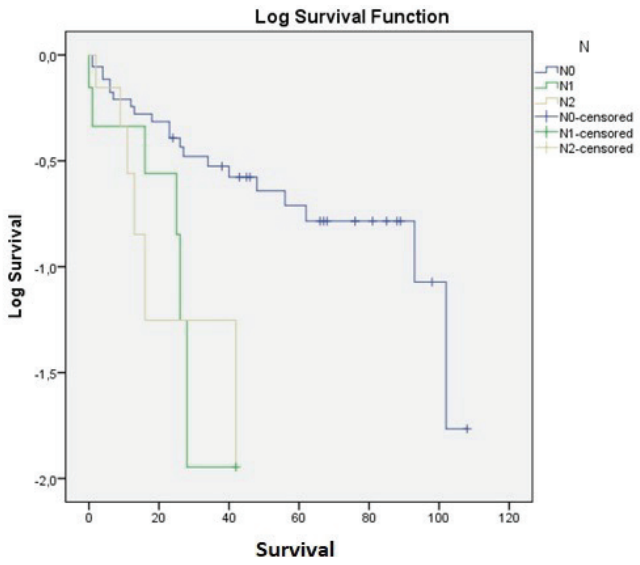

Figure 3. Survival in the case of pathologic N.

Discussion

In our study, the overall survival was 36.6%, and the median survival was 34 months in patients who underwent surgical resection after definitive treatment for locally advanced NSCLC.

Since NSCLC is a heterogeneous group with locally advanced stages, there is no clarity between treatment modalities [5]. Pathological mediastinal staging is recommended in locally advanced diseases. In N0 disease, surgical treatment has positive results if R0 resection can be achieved. There are studies in the literature indicating that an operation can be performed in the presence of single-station N2 with postoperative CT to be administered [6]. Systemic treatment is recommended primarily for patients with multi-station N2/N3 or who cannot undergo R0 resection. Thus, surgical resection can be performed on patients with R0 resection potential, avoiding pneumonectomy if possible. Definitive CRT is recommended as a systemic treatment [5-7]. Studies comparing definitive CRT and trimodal (CRT+surgery) treatment in locally advanced diseases demonstrated that disease-free survival is better in trimodal treatment, although there are similar results in terms of overall survival [5,8,9]. In our study, most patients evaluated as inoperable due to mediastinal invasion and multi/bulky N2 were referred for definitive treatment. As a definitive treatment, per the literature, CT was applied to 32 patients, CRT to 16 patients, and RT to 3 patients.

Since downstaging is known to be a major prognostic factor after induction therapy, re-staging is vital to determine subsequent therapy [6-7]. Many centers perform definitive surgery on cases that are thought to be N0 or N1 after induction therapy [10,11]. Yang et al reported that mediastinal re-staging was associated with improved survival in their Stage 3A-N2 patient series consisting of 111 patients [5]. PET-CT after induction therapy for mediastinal re-staging is of low accuracy due to the high rate of false-positive and false-negative results [12]. In minimally invasive techniques, false negativity was as high as 20-30% [13]. In a study performed with 104 patients in the literature, the sensitivity of re-mediastinoscopy was 71%, the specificity was 100%, and the accuracy rate was 81% [14]. In our study, mediastinal re-evaluation after definitive treatment was performed with mediastinoscopy in 10 patients and EBUS in 7 patients. Other patients were assessed according to PET–CT results.

In our study, the survival of N0, N1, and N2 patients after definitive treatment was better, similar to the literature. After definitive treatment, tumoral treatment was evaluated as the complete response in our Tx and Stage 0 patients, and the highest survival rates were obtained in these groups, in line with the literature.

The American Intergroup 0139 study, the European organization for cancer research and treatment (EORTC) 08941 study, and the ESPATUE study are the largest phase III studies examining treatment modalities in locally advanced diseases. The American intergroup study determined no difference in median survival in patients who received trimodal therapy and definitive therapy. Trimodal therapy was superior in progression-free survival. It was suggested that both treatment modalities could be applied [8]. In the EORTC study, two groups of patients who underwent CT+RT and chemotherapy+surgical treatment were compared, and there was no difference in the survival between the two groups. Similarly, no difference was observed in progression-free survival. CT+RT treatment has been recommended for low morbidity and mortality rates [8]. In the ESPATUE study, when the two groups that underwent definitive CRT and surgical resection after CT were compared, no difference was determined between both 5-year and progression-free survivals. It was re-

ported that the application of both treatment modalities in this group of patients positively affects survival [11].

In a phase III randomized study by Miklos Pless et al (clinicaltrials.gov number NCT00030771), surgical resection was performed on IIIA N2 patient groups, one of whom started with CT and the other with CRT. In the CRT and CT groups, the disease-free survival was 12.8 and 11.6 months, and the median survival was 37.1 and 26.2 months, respectively. There was no statistical difference between the groups. They concluded that radiotherapy did not provide additional benefit to patients undergoing surgery after chemotherapy and stated that a definitive local treatment method combined with neoadjuvant chemotherapy is sufficient to treat resectable stage IIIA/N2 non-small cell lung cancer [5].

The most discussed concepts in locally advanced diseases include potentially resectable, unresectable, and bulky N2 diseases, re-staging after induction therapy, the effectiveness of surgery and radiotherapy in combined treatments, treatment approach in persistent N2, and postoperative radiotherapy after resection in N2 diseases [11]. In our study, the median survival was 34 months, and the 5-year survival was 36.6%. Median progression-free survival was 26.23 months. Downstaging in the N factor seems to be the most important factor affecting survival in locally advanced stages. The time between definitive treatment and surgery also seems to be critical in survival. Our results were compatible with the literature.

"Salvage surgery" is still a controversial issue, but its full extent and effect on survival are unclear. In the literature, "salvage surgery" has also been defined as in patients who have locally advanced disease and need emergency surgery while under induction treatment, who were operated on only after SBRT (stereotactic body radiation therapy), who were operated on only after high-dose RT, or who could not complete induction treatment and were operated due to contraindications (Table 1). In the publications under these definitions, there are also those with R1 resection. We consider that the ideal surgical resection is R0 resection and complete mediastinal lymph node dissection. The patients in our study were patients who underwent R0 resection and were treated with different modalities as definitive treatment.

Due to the differences in the definition of "Salvage surgery," it may not be correct to compare the results in the literature with each other since the studies in the literature show differences in indications. Hence, selecting the appropriate patient for the "salvage surgery" application is vital. In other treatment methods, the median survival for patients with recurrent local lung cancer is less than 12 months [13].

After definitive treatment, lung resection may increase mortality and morbidity rates due to the risk of vascular injury and dissection difficulties as a result of the effects of definitive treatment [14,15]. In our study, the first 1-month mortality occurred in 4 (7.8%) patients, while postoperative major or minor complications developed in 9 (17.64%) patients. Our results were evaluated as consistent with the literature or even better.

After definitive treatment, the effects of definitive treatment on the lung from the time to surgery make the operation risky by creating dissection difficulties. When the literature is examined, durations longer than 12 weeks on average increase surgical morbidity and mortality due to increased fibrosis [14,15]. Our study observed that the time until the transition to surgery after definitive treatment was similar to the literature.

The widespread use of immunotherapeutic agents, such as immune checkpoint inhibitors, in the treatment of advanced non-small cell lung cancer (NSCLC) has led to the emergence of a patient cohort that responds to therapy but subsequently develops residual or oligoprogressive disease [22]. In these selected patients, salvage surgery has emerged as a feasible and safe local treatment option [23,24]. Multicentre studies have demonstrated that salvage resections following immunotherapy are predominantly lobectomies, achieve high rates of complete resection (R0), and are associated with acceptable perioperative morbidity and 30- to 90-day mortality rates [22-24]. Furthermore, a significant proportion of these patients achieve a pathological complete response (pCR), which is considered a promising prognostic indicator for long-term survival [24].

Limitations of the study

There were also some limitations in our study. The mediastinal staging was performed only before definitive treatment and/or surgery in our data. We think that the

inconsistency in mediastinal staging was due to clinical experience, changes in staging and the lack of oncology council evaluations in the first patients included in the study. All patients in the later period of our study underwent mediastinal staging both before definitive treatment and before surgery, they were evaluated in the oncology council, and their treatments were applied in line with the literature. As per the literature, we think that mediastinal "downstaging" should be evaluated in the pathological dimension for more objective data. Unfortunately, it is not possible for the evaluations to be based on an objective basis since locally advanced stage disease is a very heterogeneous group, there are quite different opinions at this stage, and the changes in staging are more common at these stages. All patients at this stage should be evaluated in oncology councils, including oncologists, chest diseases, radiation oncology, and thoracic surgery specialists. In the patients we included in our study, there was no comprehensive oncology council evaluation in our cases before 2010.

Lung resection after definitive therapy can be performed with considerable morbidity and mortality. In locally advanced diseases, evaluation should be multidisciplinary. Trimodal treatments and surgery have positive contributions to survival and disease-free survival in patients at this stage. For the definition of "salvage surgery" to be applied in locally advanced diseases, studies should be performed with more extensive patient populations. With the developing surgical techniques and imaging studies, surgery will become more applicable after definitive treatment in locally advanced diseases, making it possible to be more involved in treatment modalities.

In conclusion, salvage surgery may offer a survival benefit in carefully selected patients with advanced NSCLC following definitive treatment. Future prospective studies with larger cohorts and uniform definitions are warranted to clarify its role in multimodal management.

Declaration of conflicting interests

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Ethics approval and consent to participate

This study was conducted as part of a medical specialty thesis and was approved by the Training Commission for Medical Specialization of the University of Health Sciences, Dr. Suat Seren Chest Diseases and Thoracic Surgery Training and Research Hospital. As per national regulations applicable at the time and the institutional protocol, a separate ethical committee approval was not required for retrospective analyses of anonymized data.

Authors' contrubitions

OO and KCC design and planning the study, writing and approval of the final version. OA design and planning the study, writing, statistical analysis and approval of the final version. SOK design and planning the study; writing and approval of the final version. AU design and planning the study, statistical analysis and approval of the final version. SG design and planning the study, writing and approval of the final version. AEO and OS writing and approval of the final version.

References

1. Bunn PA. Worldwide Overview of the Current Status of Lung Cancer Diagnosis and Treatment. Arch Pathol Lab Med 2012; 136: 1478-81.
2. Hamada A, Soh J, Mitsudomi T. Salvage surgery after definitive chemoradiotherapy for patients with non-small cell lung cancer. Transl Lung Cancer Res 2021; 10: 555-62.
3. Ramnath N, Dilling TJ, Harris LJ, Kim AW, Michaud GC, Balekian AA et al. Treatment of stage III non-small cell lung cancer: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest 2013; 143: e314S-e340S.
4. Goldstraw P, Chansky K, Crowley J, Rami-Porta R, Asamura H, Eberhardt WE et al. The IASLC lung cancer staging project: Proposals for revision of the TNM stage groupings in the forthcoming (eighth) edition of the TNM classification for lung cancer. J Thorac Oncol 2016; 11: 39-51.
5. Pless M, Stupp R, Ris HB, Stahel RA, Weder W, Thierstein S et al. Induction chemoradiation in stage IIIA/N2 non-small-cell lung cancer: a phase 3 randomised trial. Lancet 2015; 386: 1049-56.
6. Tsitsias T, Boulemden A, Ang K, Nakas A, Waller DA. The N2 paradox: similar outcomes of pre- and postoperatively identified single-zone N2a positive non-small-cell lung cancer. Eur J Cardiothorac Surg 2014; 45: 882-7.

7. Ahn JS, Ahn YC, Kim JH, Lee CG, Cho EK, Lee KC et al. Multinational randomized phase III trial with or without consolidation chemotherapy using docetaxel and cisplatin after concurrent chemoradiation in inoperable stage III non–small-cell lung cancer: KCSG-LU05-04. J Clin Oncol 2015; 33: 2660-6.
8. Albain K, Swann RS, Rusch VW, Turrisi AT, Shepherd FA, Smith C et al. Radiotherapy plus chemotherapy with or without surgical resection for stage III non-small-cell lung cancer: a phase III randomized controlled trial. Lancet 2009; 374: 379-86.
9. Van Meerbeeck JP, Kramer GW, Van Schil PE, Legrand C, Smit EF, Schramel F et al. Randomized controlled trial of resection versus radiotherapy after induction chemotherapy in stage IIIA-N2 non- small-cell lung cancer. J Natl Cancer Inst 2007; 99: 442-50.
10. Van Schil P, Van Meerbeeck J, Kramer G, Splinter T, Legrand C, Giaccone G et al. Morbidity and mortality in the surgery arm of EORTC 08941 trial. Eur Respir J 2005; 26: 192-7.
11. Eberhardt WE, Pottgen C, Gauler TC, Friedel G, Veit S, Heinrich V et al. Phase III Study of Surgery Versus Definitive Concurrent Chemoradiotherapy Boost in Patients With Resectable Stage IIIA(N2) and Selected IIIB Non-Small-Cell Lung Cancer After Induction Chemotherapy and Concurrent Chemoradiotherapy (ESPATUE). J Clin Oncol 2015; 33: 4194-201.
12. Van Schil PE, Yogeswaran K, Hendriks JM, Lauwers P, Faivre-Finn C. Advances in the use of surgery and multimodality treatment for N2 non-small cell lung cancer. Expert Rev Anticancer Ther 2017; 17: 555-61.
13. Noble J, Ellis PM, Mackay JA, Evans WK. Second-line or subsequent systemic therapy for recurrent or progresive non-small cell lung cancer: a systematic review and practice guideline. J Thorac Oncol 2006; 1: 1042-58.
14. Yang CJ, Meyerhoff RR, Stephens SJ, Singhapricha T, Toomey CB. Long-Term Outcomes of Lobectomy for Non-Small Cell Lung Cancer After Definitive Radiation Treatment. Ann Thorac Surg 2015; 99: 1914-20.
15. Bauman JE, Mulligan MS, Martins RG, Kurland BF, Eaton KD, Wood DE. Salvage lung resection after definitive radiation (>59 Gy) for non-small cell lung cancer: surgical and oncologic outcomes. Ann Thorac Surg 2008; 86: 1632-8.
16. Uramoto H, Tanaka F. Salvage thoracic surgery in patients with primary lung cancer. Lung Cancer 2014; 84: 151-5.
17. Dickhoff C, Dahele M, Paul MA, van de Ven PM, de Langen AJ, Senan S et al. Salvage surgery for locoregional recurrence or persistent tumor after high dose chemoradiotherapy for locally advanced non-small cell lung cancer. Lung Cancer 2016; 94: 108-13.
18. Schreiner W, Dudek W, Lettmaier S, Fietkau R, Sirbu H. Should salvage surgery be considered for local recurrence after definitive chemoradiation in locally advanced non-small cell lung cancer. J Cardiothorac Surg 2016; 11: 1-7.
19. Verstegen NE, Maat APWM, Lagerwaard FJ, Paul MA, Versteegh MI, Joosten JJ et al. Salvage surgery for local failures after stereotactic ablative radiotherapy for early stage non-small cell lung cancer. Radiat Oncol 2016; 11: 131.
20. Shimada Y, Suzuki K, Okada M, Nakayama H, Ito H, Mitsudomi T et al. Feasibility and efficacy of salvage lung resection after definitive chemoradiation therapy for stage III non-small-cell lung cancer. Interact Cardiovasc Thorac Surg 2016; 23: 895-901.
21. Mizobuchi T, Yamamoto N, Nakajima M, Baba M, Miyoshi K, Nakayama H et al. Salvage surgery for local recurrence after carbon ion radiotherapy for patients with lung cancer. Eur J Cardiothorac Surg 2016; 49: 1503-9.
22. Ueno T, Yamashita M, Yamashita N, Uomoto M, Kawamata O, Sano Y et al. Safety of salvage lung resection after immunotherapy for unresectable non-small cell lung cancer. Gen Thorac Cardiovasc Surg 2022; 70: 812-7.
23. Nemeth A, Canavan ME, Zhan PL, Udelsman BV, Ely S, Wigle DA et al. Salvage lung resection after immunotherapy is feasible and safe. JTCVS Open 2024; 20: 141-50.
24. Chiappetta M, Sassorossi C, Lococo F, Guerrera F, Ruffini E, Lyberis P et al. Short-term results of salvage surgery after immune and target therapies in non-small cell lung cancer. J Thorac Dis 2025; 17: 4929-39.