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#### ORIGINAL ARTICLE

# Station 3A lymph node dissection does not improve long-term survival in right-side operable non-small-cell lung cancer patients: A propensity score matching study

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#### Abstract

**Background:** To investigate the impact of station 3A lymph node dissection (LND) on overall survival (OS) and disease-free survival (DFS) in completely resected right-side non-small-cell lung cancer (NSCLC) patients.

**Methods:** A total of 1661 cases with completely resected right-side NSCLC were included. Propensity score matching (PSM) was performed to minimize selection bias, and a logistic regression model was conducted to investigate the risk factors associated with station 3A lymph node metastasis (LNM). The Kaplan–Meier method and Cox proportional hazards model were used to evaluate the impact of station 3A LND on survival.

**Results:** For the entire cohort, 503 patients (30.3%) underwent station 3A LND. Of those, 11.3% (57/503) presented station 3A LNM. Univariate and multivariate logistic analyses showed that station 10 LNM, tumor location, and the number of resected lymph nodes were independent risk factors associated with station 3A LNM. Before PSM, patients with station 3A LND had worse 5-year OS (p = 0.002) and DFS (p = 0.011), and more drainage on postoperative day 1 (p = 0.041) than those without. After PSM, however, station 3A LND was not associated with the 5-year OS (65.7% vs. 63.6%, p = 0.432) or DFS (57.4% vs. 56.0%, p = 0.437). The multivariate analysis further confirmed that station 3A LND was not a prognostic factor (OS, p = 0.361; DFS, p = 0.447).

**Conclusions:** Station 3A LND could not improve long-term outcomes and it was unnecessary to dissect station 3A lymph nodes during surgery of right-side NSCLC.

#### **KEYWORDS**

mediastinal lymph node dissection, non-small-cell lung cancer, prognosis

#### INTRODUCTION

Anatomical lobectomy combined with mediastinal lymph node dissection (MLND) has been confirmed as the standard surgical treatment for early-stage non-small-cell lung cancer

<sup>†</sup>These authors contributed equally to this paper and share the first authorship.

(NSCLC).<sup>1–5</sup> It has been widely accepted that MLND could improve staging accuracy and long-term survival.<sup>6–8</sup> However, the optimal extent of MLND has not yet been well determined.<sup>9–13</sup> According to clinical guidelines, at least three mediastinal lymph node stations (including station 7) should be examined, but which station except for station 7 should be routinely resected has not been well elucidated.<sup>3–5</sup>

In our previous studies, we demonstrated that the metastasis of station 3A in operatable right-side NSCLC was not

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rare (11.7%),<sup>14</sup> even in tumors  $\leq 3$  cm (9.6%),<sup>15</sup> which indicated that station 3A LND might be helpful to improve long-term outcomes in these patients. Unfortunately, strong evidence on this issue is lacking, and station 3A LND is often neglected by thoracic surgeons in real-world practice.<sup>14–16</sup> It is therefore very important to investigate if station 3A LND is essential for surgical resection of rightside NSCLCs.

In this study, we used a large cohort of patients with right-side NSCLC to investigate the impact of station 3A LND on accurate staging and long-term survival. The large number, long-term follow-up, and propensity score matching (PSM) between groups improve the reliability of this study.

#### **METHODS**

#### Patient selection

We used a database that included 5346 patients with operable NSCLC who underwent consecutive pulmonary resections at Sun Yat-sen University Cancer Center from January 2001 to December 2014, as previously described.<sup>14,15,17</sup> The authenticity of this article has been validated by uploading the key raw data on the Research Data Deposit (RDD) public platform (www.researchdata.org.cn), with approval of RDD number RDDA2021002024 authorized by the Institutional Review Board of Sun Yat-sen University Cancer Center. The inclusion criteria were as follows: (i) patients presented with primary right-side NSCLC; (ii) complete resection was performed based on the International Association for the Study of Lung Cancer (IASLC) criteria<sup>18</sup>; and (iii) the tumor pathological stage was T1-4N0-2M0. Patients with the following characteristics were excluded: (i) other concurrent or previous primary cancers; (ii) preoperative neoadjuvant therapy; (iii) sublobar resection (including segmentectomy and wedge resection); and (iv) operative mortality. Operative mortality was defined as death within 30 days of operation or at any time after the operation if the patient did not leave the hospital alive.<sup>19</sup> Finally, 1661 patients were included in this study. These patients were further divided into two groups: patients with station 3A LND (station 3A LND<sup>+</sup> group) and patients without station 3A LND (station 3A LND<sup>-</sup> group). The 8th edition of the lung cancer stage classification system of the American Joint Committee on Cancer was used to restage all of these patients.<sup>20</sup>

Preoperative evaluations for staging have been described elsewhere.<sup>15,17</sup> All patients underwent preoperative evaluation that included a chest computed tomography (CT), brain CT, or magnetic resonance imaging, abdominal ultrasonography or CT scan, and bone scan. Positron emission tomography (PET) was not routinely performed since it is not covered by medical insurance in mainland China. For those patients who underwent CT scans or PET scans of mediastinal lymph nodes that yielded a positive result, an endobronchial ultrasound biopsy or mediastinoscopic examination was recommended.<sup>15,17</sup>

#### Assessment of MLNM

Mediastinal lymph nodes were grouped into different "stations" and "zones" (upper zone [stations 2R, 3A, and 4R], subcarinal [SC] zone [station 7], and lower zone [stations 8 and 9]) based on the IASLC lymph node map.<sup>21</sup> The MLNM rate of a certain station/zone was defined as the number of patients whose lymph nodes in this station/zone were involved divided by the number of patients whose lymph nodes in this station/zone were resected for examination, as we described previously.<sup>14,15,17</sup> The MLNM rates of each station/zone were calculated and compared between different lobes. Furthermore, the clinical characteristics associated with MLNM were identified to determine which type of patients were more likely to have N2 disease.

#### Follow-up

In general, follow-up examinations were recommended every 3 months for the first 2 years, every 6 months for the next 3-5 years, and once a year thereafter. At each follow-up visit, a physical examination, serum tumor marker test, spiral contrast-enhanced chest CT scan, and abdominal sonography were carried out. If the patient had specific symptoms, the examination was performed as soon as possible for a more careful assessment.<sup>15,17</sup> Abdomen CT scans, bone scans, and brain magnetic resonance imaging scans were carried out when clinically indicated. Follow-up information was last updated in April 2019 or on the date of death. Patients without an event were censored at the time last known to be alive. The median time from the date of surgery to the last contact with the patients was 55 months (range 1-210 months). During the follow-up period, 42.6% (708/1661) of included patients occurred death/recurrence and 5.3% (88/1661) of included patients were lost to follow-up.

#### **PSM** analysis

PSM analysis was used to minimize selection bias.<sup>22</sup> A logistic regression model that included sex, age, tumor location, anatomical type, smoking history, comorbidity, surgical resection, surgical approach, histology, cell differentiation, adjuvant therapy, complications, pT category, pN category, and resected lymph node number was used to calculate the propensity score of each case. Patients from the two groups (station 3A LND<sup>+</sup> group vs. station 3A LND<sup>-</sup> group) were matched in a 1:1 ratio according to propensity scores using a nearest-neighbor approach with caliper restrictions. R version 4.0.2 software (Bell Laboratories, https://cran.r-project. org/bin/windows/base/R-4.0.2-win.exe) was used to perform the PSM analysis.

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TABLE 1 General clinicopathological characteristics of patients with and without station 3A LND before and after propensity score matching

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IIIj87 (30.8)j88 (39.4)j88 (38.3)j91 (38.7)Pathocyal T category0.230.230.250.25T51 (46.7)22 (45.3)22 (45.5)22 (45.5)T315 (51.1)74 (50.9)80 (16.2)74 (15.0)T40.26 (20.3)16 (0.5)80 (16.2)74 (15.0)T40.26 (20.3)16 (0.5)277 (56.1)285 (57.7)N0743 (42.2)87 (51.1)277 (56.1)285 (57.7)N1139 (12.0)67 (11.3)64 (13.0)55 (11.1)N20.26 (3.8)159 (3.1)153 (3.10)16 (3.2)Tumor location126 (10.9)79 (15.7)64 (13.0)71 (5.6)RML126 (10.9)159 (15.3)270 (34.7)256 (51.8)RML126 (10.9)15 (13.9)16 (14.0)71 (15.6)RML127 (11.0)15 (13.9)26 (14.0)71 (15.6)RML101 (89.0)258 (51.7)26 (57.7)26 (57.7)Newer59 (51.8)0.21 (51.8)26 (57.7)RML126 (10.9)70 (15.2)10.2071 (5.6)RML126 (10.9)15 (13.8)16 (14.0)71 (15.6)RML126 (10.9)15 (13.8)16 (14.0)71 (15.6)RML127 (11.0)75 (14.9)25 (50.7)26 (57.7)Periperal10.10 (80.0)21 (53.8)21 (53.8)25 (57.7)Newer54 (97.4)25 (45.7)25 (57.7)26 (57.7)Newer54 (14.9)23 (45.7)24 (49.7)	II	259 (22.4)	97 (19.3)		107 (21.7)	97 (19.6)	
Pathological T category0.2380.726T37 (30.)152 (30.)155 (31.4)151 (30.)T251 (46.7)28 (45.3)224 (45.3)225 (45.7)T3175 (15.1)76 (55.7)20 (10.2)74 (50.7)T472 (62.7)45 (8.9)35 (7.1)48 (8.9)Pathological N category72 (62.7)28 (57.7)285 (57.7)N073 (64.2)287 (57.1)277 (56.1)285 (57.7)N1199 (12.0)57 (13.0)154 (13.0)55 (1.1)N2276 (23.8)159 (31.6)153 (31.0)154 (32.7)Tumor location199 (12.0)259 (51.5)270 (54.7)265 (51.8)RML619 (35.7)259 (51.5)270 (54.7)256 (51.8)RML13 (35.7)156 (32.8)160 (32.4)161 (32.6)RML13 (35.7)75 (14.9)69 (14.0)70 (14.2)Peripheral102 (19.0)75 (14.9)69 (14.0)70 (14.2)Peripheral102 (19.0)75 (14.9)69 (14.0)70 (14.2)Never02.6232 (45.1)24 (45.8)24 (45.8)Comorbity103 (80.0)23 (45.7)23 (45.7)23 (45.7)Never54 (50.4)23 (45.7)23 (45.1)26 (55.7)Never54 (50.4)23 (45.7)23 (45.7)24 (45.8)Never54 (50.4)23 (45.1)26 (55.7)24 (55.7)Never54 (50.4)24 (49.2)24 (49.4)24 (49.4)Yes54 (50.5)25 (50.8) <t< td=""><td>III</td><td>357 (30.8)</td><td>198 (39.4)</td><td></td><td>189 (38.3)</td><td>191 (38.7)</td><td></td></t<>	III	357 (30.8)	198 (39.4)		189 (38.3)	191 (38.7)	
T1370 (32.0)12 (30.2)155 (31.4)151 (30.6)T2541 (46.7)228 (45.3)224 (45.3)225 (45.5)T3175 (15.1)78 (15.5)80 (16.2)74 (15.0)T472 (62.1)78 (15.7)80 (16.2)74 (15.0)Pathological N category0.73 (16.2)287 (57.1)277 (56.1)285 (57.7)N1139 (10.0)57 (11.3)64 (13.0)55 (11.1)N2276 (23.8)159 (31.6)153 (31.0)150 (13.1)Tumor location126 (19.5)259 (51.5)270 (54.7)256 (51.8)RUL619 (53.5)259 (51.5)60 (32.4)161 (32.6)RUL136 (37.7)165 (32.8)160 (32.4)161 (32.6)Rut131 (35.7)165 (32.8)69 (14.0)70 (14.2)Central127 (11.0)75 (14.9)69 (14.0)70 (14.2)Prepheral130 (30.6)230 (45.7)223 (45.1)226 (45.7)Sumoking history0.952.6273 (54.3)213 (32.1)266 (57.7)Current/former69 (92.6)273 (54.3)213 (32.1)264 (57.7)No54 (94.6)249 (49.5)232 (45.1)226 (45.7)Surgical approach54 (30.4)230 (45.7)223 (45.1)226 (45.7)No54 (94.6)249 (49.5)232 (45.1)236 (57.7)Thoraccomp69 (16.3)376 (74.8)379 (76.7)360 (76.8)Surgical approach54 (30.6)376 (74.8)379 (76.7)360 (76.8)Thoraccomp61 (	Pathological T category			0.238			0.726
T2541 (467)28 (45.3)224 (45.3)225 (45.5)T3175 (15.1)78 (15.5)80 (16.2)74 (15.0)T402.0278 (5.5)0.00474 (4.9)Pabalogical N category0.43 (4.2)287 (57.1)275 (56.1)285 (57.7)N1139 (12.0)57 (11.3)64 (13.0)55 (11.1)N202 (23.8)159 (31.6)201 (54.7)265 (51.8)Tumor location52 (91.5)270 (54.7)256 (51.8)RUL619 (35.7)165 (32.8)160 (32.4)161 (32.6)RLL132 (50.9)79 (15.7)64 (13.0)77 (15.6)RLL133 (57.7)165 (32.8)160 (32.4)161 (32.6)Peripheral137 (11.0)75 (14.9)69 (14.0)70 (14.2)Peripheral103 (89.0)428 (85.1)223 (45.1)226 (45.7)Never594 (54.7)230 (45.7)250 (50.6)270 (54.7)Never103 (89.0)428 (85.1)260 (30.4)20.60Never59 (15.6)270 (54.7)263 (57.7)29.60No574 (49.6)230 (45.7)213 (45.8)29.60No54 (50.4)240 (50.5)21 (50.8)20.60Surgical approach57 (49.9)294 (45.7)20.60Thoracotomy81 (75.2)127 (22.2)15 (23.3)215 (23.3)Surgical approach56 (16.1)249 (49.5)215 (50.8)21.60Thoracotomy81 (75.6)40 (81.1)398 (80.6)40.61Biobectomy <td< td=""><td>T1</td><td>370 (32.0)</td><td>152 (30.2)</td><td></td><td>155 (31.4)</td><td>151 (30.6)</td><td></td></td<>	T1	370 (32.0)	152 (30.2)		155 (31.4)	151 (30.6)	
T3175 (15.)78 (15.5)80 (16.2)74 (15.0)T472 (6.2)45 (8.9)35 (7.1)44 (8.9)Pablogical N category0.048.9 (7.7)6.71N139 (12.0)287 (7.51.1)277 (56.1)55 (1.1.)N1139 (2.0.3)159 (1.6)153 (31.0)154 (3.2.)N2276 (23.8)159 (1.6)270 (54.7)256 (51.8)RUL619 (35.7)259 (51.5)270 (54.7)256 (51.8)RML126 (10.9)79 (15.7)64 (13.0)71 (15.0)RL1131 (18.0)428 (82.1)69 (14.0)70 (14.2)Periphral131 (8.0)428 (82.1)69 (14.0)70 (14.2)Periphral103 (8.0)428 (82.1)223 (45.1)226 (45.7)Never549 (47.1)75 (14.9)223 (45.1)226 (45.7)No549 (47.1)75 (14.9)231 (45.7)201 (12.0)No549 (47.1)75 (14.9)231 (45.7)201 (12.0)No549 (47.1)76 (43.9)213 (45.1)266 (54.3)Surgial protech76 (75.1)369 (77.1)97 (75.7)369 (77.1)No54 (47.2)127 (12.2)115 (23.3)125 (25.3)Surgial resection137 (15.2)76 (14.9)398 (80.6)369 (14.9)No54 (47.2)127 (12.2)115 (23.3)125 (25.3)Surgial resection137 (15.2)137 (15.2)137 (15.2)Surgial resection136 (17.1)137 (12.2)137 (15.2)Bib	T2	541 (46.7)	228 (45.3)		224 (45.3)	225 (45.5)	
T472 (2)84 (8)35 (7.1)44 (8.9)Pathological N category0743 (64.2)287 (57.1)270 (54.1)285 (57.7)N0139 (12.0)57 (11.3)64 (13.0)55 (11.1)N227 (23.8)159 (13.6)133 (31.0)154 (13.0)Tumor location61 (53.5)290 (51.5)270 (54.7)266 (51.8)RUL61 (53.5)299 (51.5)61 (13.0)77 (15.6)RUL143 (57.7)160 (23.4)160 (23.4)70 (16.2)RL141 (35.7)152 (15.9)160 (23.4)71 (56.9)Anatomical type127 (11.0)75 (14.9)69 (14.0)70 (14.2)Peripheral103 (18.0)428 (85.1)425 (86.0)424 (85.8)Never609 (25.4)233 (45.7)223 (45.1)266 (53.7)Querre former609 (26.4)233 (45.7)223 (45.1)266 (53.7)No54 (14.9)233 (45.7)21 (54.9)286 (54.3)No54 (14.9)234 (45.9)244 (49.4)21Yers69 (53.6)23 (45.7)26 (53.7)69 (73.7)No54 (14.9)21 (25.2)15 (23.3)26 (53.7)No54 (14.9)21 (25.2)15 (23.3)26 (53.7)No54 (14.9)21 (25.2)21 (50.3)21 (50.9)No54 (15.3)15 (12.5)15 (13.3)21 (51.3)No54 (14.9)21 (25.2)15 (23.3)21 (51.2)No54 (14.9)21 (25.2)15 (23.3)21 (25.3)No <td>Т3</td> <td>175 (15.1)</td> <td>78 (15.5)</td> <td></td> <td>80 (16.2)</td> <td>74 (15.0)</td> <td></td>	Т3	175 (15.1)	78 (15.5)		80 (16.2)	74 (15.0)	
Pabalogical N category004034 (64.2)037 (57.1)027 (56.1)028 (57.7)N1139 (12.0)57 (11.3)64 (13.0)55 (11.1)N202 (02.3)15 (13.0)64 (13.0)55 (11.1)N202 (02.3)15 (13.0)23 (13.0)15 (13.2)Tumor location126 (10.9)259 (51.5)270 (54.7)256 (51.8)RUL61 (13.0)79 (15.7)64 (13.0)77 (15.6)RLL13 (57.7)156 (32.8)160 (32.4)161 (32.6)Anatorial type126 (10.9)75 (14.9)69 (14.0)70 (14.2)Peripheral103 (18.00)425 (80.1)425 (80.1)426 (87.1)Peripheral103 (18.00)230 (45.7)221 (54.9)268 (54.3)Never59 (97.4)230 (45.7)221 (54.9)268 (54.3)Never69 (52.6)233 (54.3)221 (54.9)244 (49.4)No57 (49.6)249 (45.0)231 (50.2)244 (49.4)No57 (49.6)249 (45.0)231 (50.2)244 (49.4)No58 (53.4)231 (50.2)215 (25.3)21.5Iprical approach150 (25.6)127 (25.2)151 (23.3)152 (25.3)Iprical approach150 (25.6)127 (25.2)152 (25.3)21.5Iprical resction163 (13.6)376 (74.8)379 (76.7)39 (74.7)Iprical resction150 (25.6)152 (25.3)152 (25.3)152 (25.3)Iprical resction150 (15.2)153 (153.6)153 (153.6)153 (153.6)	T4	72 (6.2)	45 (8.9)		35 (7.1)	44 (8.9)	
No       743 (64.2)       287 (57.1)       277 (56.1)       285 (57.7)         N1       139 (12.0)       57 (11.3)       64 (13.0)       55 (11.1)         N2       276 (23.8)       159 (31.6)       153 (31.0)       154 (31.2)         Tumor location       0.021       0.025         RUL       619 (53.5)       259 (51.5)       270 (54.7)       64 (13.0)       77 (15.6)         RLL       133 (35.7)       165 (32.8)       160 (32.4)       161 (32.6)       0.021         Anatomical type       70 (15.7)       64 (13.0)       77 (15.6)       0.021       0.021         Central       127 (11.0)       75 (14.9)       69 (14.0)       70 (14.2)       0.027         Peripheral       1031 (89.0)       428 (85.1)       425 (86.0)       424 (85.0)       0.021         Smoking history       0.528       0.548         Never       549 (47.4)       230 (45.7)       223 (45.1)       226 (45.7)         Quartert/former       609 (52.6)       230 (45.7)       233 (43.2)       244 (49.4)         No       549 (47.4)       230 (45.7)       251 (50.8)       252 (50.6)       251 (50.8)       252 (50.6)         Toracoscopic       851 (73.5) <td>Pathological N category</td> <td></td> <td></td> <td>0.004</td> <td></td> <td></td> <td>0.671</td>	Pathological N category			0.004			0.671
NI         139 (12.0)         57 (11.3)         64 (13.0)         55 (11.1)           N2         276 (23.8)         159 (31.6)         153 (31.0)         154 (31.2)           Tumor location         619 (53.5)         259 (51.5)         270 (54.7)         256 (51.8)           RUL         619 (53.5)         259 (51.5)         270 (54.7)         256 (51.8)           RUL         413 (35.7)         165 (32.6)         161 (32.6)           RLL         413 (35.7)         157 (14.9)         69 (14.0)         70 (14.2)           Anatomical type         127 (11.0)         75 (14.9)         69 (14.0)         70 (14.2)           Peripheral         103 (89.0)         428 (85.1)         425 (86.0)         424 (85.8)           Swer         59 (97.4)         230 (45.7)         233 (45.1)         226 (45.7)           Current/former         69 (52.6)         233 (45.1)         236 (45.7)         244 (49.4)           Yes         54 (50.4)         24 (49.5)         243 (49.2)         244 (49.4)           Yes         54 (50.4)         24 (49.5)         251 (50.8)         250 (50.6)           Tyrigical approach         570 (42.6)         157 (49.6)         376 (49.6)         379 (76.7)         369 (74.7)           Thora	N0	743 (64.2)	287 (57.1)		277 (56.1)	285 (57.7)	
N2       276 (2.8)       159 (31.6)       153 (31.0)       154 (31.2)         Tumor location       0.021       0.021       0.0455         RUL       619 (53.5)       259 (51.5)       270 (54.7)       256 (51.8)         RML       126 (10.9)       79 (15.7)       64 (13.0)       77 (15.6)         RLL       13 (35.7)       16 (32.8)       16 (12.2)       16 (12.6)         Amatorial type       0.024       16 (13.6)       0.024         Central       177 (11.0)       75 (14.9)       60 (40.0)       70 (14.2)         Peripheral       103 (18.0)       24 (85.1)       425 (86.0)       424 (85.8)         Smoking history       159 (47.4)       230 (45.7)       233 (45.1)       256 (45.3)         Querent/former       69 (52.6)       23 (45.1)       256 (53.3)       256 (53.3)         Current/former       69 (52.6)       23 (45.1)       256 (45.3)       256 (45.3)         Surgical approach       757 (49.6)       249 (49.5)       215 (50.8)       236 (45.7)       269 (47.7)         Thoracotomy       51 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)       369 (74.7)         Thoracotomy       51 (73.5)       157 (53.8)       379 (76.7)       369 (74.7)	N1	139 (12.0)	57 (11.3)		64 (13.0)	55 (11.1)	
Turor location0.0210.0510.054RUL619 (53.5)259 (51.5)270 (54.7)256 (51.8)RML126 (10.9)79 (15.7)64 (13.0)77 (15.6)RL413 (35.7)165 (32.8)160 (32.4)161 (32.6)Anarocal type0.024160 (32.4)161 (32.6)0.024Central127 (11.0)75 (14.9)69 (14.0)70 (14.2)Peripheral130 (80.0)428 (85.1)426 (85.0)424 (85.8)Smoking type0.528223 (45.1)226 (45.7)0.048Never549 (47.4)230 (45.7)231 (51.9)268 (54.3)Current/former69 (52.6)233 (45.7)234 (49.4)246 (49.4)No549 (49.6)249 (49.5)231 (50.8)244 (49.4)Yes549 (49.6)249 (49.5)231 (50.8)244 (49.4)Yes541 (53.5)246 (55.7)251 (50.8)250 (50.6)Surgical approach574 (49.6)249 (49.5)243 (49.2)244 (49.4)Yes543 (50.5)251 (50.8)250 (50.6)251 (50.8)Thoracotomy574 (54.3)376 (74.8)379 (76.7)369 (74.7)Thoracotomy127 (25.2)151 (23.3)125 (25.3)Thoracotomy136 (13.7)74 (14.7)77 (15.6)314 (8.6)Jebetomy191 (85.6)408 (81.1)398 (80.6)403 (81.6)Jebetomy192 (51.7)120 (20.1)150.8)136 (20.1)Jebetomy136 (17.7)71 (16.1)71 (16.3)161 (	N2	276 (23.8)	159 (31.6)		153 (31.0)	154 (31.2)	
RUL619 (53.5)259 (51.5) $270 (54.7)$ 26 (51.8)RML126 (10.9)79 (15.7)64 (13.0)77 (15.6)RLL413 (35.7)165 (32.8)160 (32.4)161 (32.6)Anatomical type0.26 (14.9)69 (14.0)70 (14.2)Peripheral1031 (89.0)428 (85.1)69 (14.0)70 (14.2)Peripheral1031 (89.0)428 (85.1)425 (86.0)424 (85.8)Never549 (47.4)230 (45.7)233 (45.1)266 (45.7)Current/former690 (52.6)230 (54.3)271 (54.9)268 (54.3)Comorbidity574 (49.6)249 (49.5)231 (49.2)246 (49.4)Yes548 (50.4)254 (50.5)251 (50.8)250 (50.6)Surgical approach574 (49.6)247 (49.5)251 (50.8)250 (50.6)Surgical resection370 (26.5)127 (25.2)115 (23.3)125 (25.3)Inforacoscopic307 (26.5)127 (52.2)151 (23.3)125 (25.3)Indectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bibbectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Bibbectomy136 (11.7)21 (63.8)303 (61.3)317 (64.2)Histology $321 (63.8)$ 303 (61.3)317 (64.2)153 (25.9)Comorbidity $317 (27.4)$ 320 (26.2)143 (28.9)128 (25.9)Others126 (13.9)52 (50.9)48 (9.7)49 (9.9)	Tumor location			0.021			0.455
RML126 (10.9)79 (15.7)64 (13.0)77 (15.6)RLL413 (35.7)165 (32.8)160 (32.4)161 (32.6)Anatomical type $0.13 (35.7)$ $0.5 (32.8)$ $0.6 (32.4)$ $0.6 (32.4)$ $0.6 (32.4)$ Anatomical type $0.27 (14.9)$ $69 (14.0)$ $70 (14.2)$ $0.01 (2.2)$ Peripheral $0.01 (89.0)$ $428 (85.1)$ $425 (86.0)$ $424 (85.8)$ Smoking history $0.91 (2.6)$ $230 (45.7)$ $223 (45.1)$ $226 (45.7)$ Current/former $69 (26.6)$ $230 (45.7)$ $213 (49.2)$ $244 (49.4)$ Comorbidity $574 (49.6)$ $249 (49.5)$ $243 (49.2)$ $244 (49.4)$ Yes $548 (50.4)$ $254 (50.5)$ $251 (50.8)$ $250 (50.6)$ Surgical approach $574 (49.6)$ $254 (50.5)$ $251 (50.8)$ $250 (50.6)$ Surgical approach $51 (73.5)$ $76 (74.8)$ $379 (76.7)$ $369 (74.7)$ Thoracotomy $81 (73.5)$ $76 (74.8)$ $379 (76.7)$ $369 (74.7)$ Indicatomy $91 (85.6)$ $408 (81.1)$ $398 (80.6)$ $403 (81.6)$ Bibobertomy $13 (21.7)$ $74 (14.7)$ $71 (15.6)$ $73 (14.8)$ Pneumonectomy $31 (2.7)$ $21 (2.2)$ $103 (30 (61.3)$ $317 (64.2)$ Histogy $70 (66.5)$ $321 (63.8)$ $303 (61.3)$ $317 (64.2)$ Others $70 (65.5)$ $50 (9.9)$ $48 (9.7)$ $49 (9.9)$	RUL	619 (53.5)	259 (51.5)		270 (54.7)	256 (51.8)	
RLL413 (35.7)165 (32.8)160 (32.4)161 (32.6)92 (32.6)Anatomical type0.270.0240.0240.027Central127 (11.0)75 (14.9)69 (14.0)70 (14.2)Peripheral1031 (89.0)428 (85.1)425 (86.0)424 (85.8)Smoking history0.5280.5280.5280.528Never549 (47.4)230 (45.7)223 (45.1)226 (45.7)Current/former609 (52.6)273 (54.3)271 (54.9)268 (54.3)Comorbidity69 (52.6)233 (45.7)244 (49.4)0.99No574 (49.6)249 (49.5)243 (49.2)244 (49.4)Yes584 (50.4)254 (50.5)251 (50.8)250 (50.6)Surgical approach574 (49.6)127 (25.2)115 (23.3)125 (25.3)Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracosopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical reservin0.0550.0510.0210.021I bobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Biblobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)I bobectomy136 (11.7)21 (63.8)303 (61.3)317 (64.2)Histology700 (65.5)521 (63.8)303 (61.3)317 (64.2)Adenocarinoma70 (66.5)521 (63.8)303 (61.3)317 (64.2)Adenocarinoma70 (60.5)521 (63.9)143 (28.9)128 (25.9)	RML	126 (10.9)	79 (15.7)		64 (13.0)	77 (15.6)	
Anatomical type       0.024       0.024       0.024         Central       127 (11.0)       75 (14.9)       69 (14.0)       70 (14.2)         Peripheral       1031 (89.0)       428 (85.1)       425 (86.0)       424 (85.8)         Smoking history       549 (47.4)       230 (45.7)       233 (45.1)       226 (45.7)         Current/former       609 (52.6)       273 (54.3)       271 (54.9)       268 (54.3)         Current/former       609 (52.6)       273 (54.3)       271 (54.9)       268 (54.3)         Comorbidity       574 (49.6)       249 (49.5)       243 (49.2)       244 (49.4)         Yes       584 (50.4)       254 (50.5)       251 (50.8)       250 (50.6)         Strigical approach       574 (49.6)       247 (52.2)       215 (50.8)       250 (50.6)         Thoracotomy       584 (50.4)       254 (50.5)       251 (50.8)       250 (50.6)         Thoracotomy       816 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracotomy       816 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Ibolectomy       91 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)         Jebectomy       91 (85.6)       408 (81.1)       398 (80.6) <td< td=""><td>RLL</td><td>413 (35.7)</td><td>165 (32.8)</td><td></td><td>160 (32.4)</td><td>161 (32.6)</td><td></td></td<>	RLL	413 (35.7)	165 (32.8)		160 (32.4)	161 (32.6)	
Central127 (11.0)75 (14.9)69 (14.0)70 (14.2)Peripheral1031 (89.0)428 (85.1)425 (86.0)424 (85.8)Smoking history $0.528$ $0.528$ $0.23 (45.1)$ 226 (45.7)Current/former609 (52.6)273 (54.3)271 (54.9)268 (54.3)Comorbidity $0.981$ $0.949$ 949 (49.5)243 (49.2)244 (49.4)Yes584 (50.4)249 (49.5)231 (50.8)250 (50.6)Surgical approach $0.590$ 251 (50.8)250 (50.6)0.458Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracocopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection $0.055$ $0.055$ $0.921$ Lobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy91 (85.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (4.2)19 (3.8)18 (3.6)Histology $0.27$ $0.023$ $0.561$ Adenocarcinoma $770 (66.5)$ $321 (63.8)$ $030 (61.3)$ $317 (64.2)$ Others $10 (0.1)$ $50 (9.9)$ $48 (9.7)$ $49 (9.9)$	Anatomical type			0.024			0.927
Peripheral1031 (89.0)428 (85.1)425 (86.0)424 (85.8)Smoking history $549$ (47.4)230 (45.7)223 (45.1)226 (45.7)Current/former609 (52.6)273 (54.3)271 (54.9)268 (54.3)Comorbidity $574$ (49.6)249 (49.5)243 (49.2)244 (49.4)Yes584 (50.4)249 (9.5)251 (50.8)250 (50.6)Surgical approach $574$ (49.6)244 (50.5)251 (50.8)250 (50.6)Surgical approach $574$ (49.7)376 (74.8)379 (76.7)369 (74.7)Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracocopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection136 (11.7)74 (14.7)77 (15.6)73 (14.8)Bibloetomy31 (2.7)21 (4.2)19 (3.8)403 (81.6)Histology770 (66.5)321 (63.8)303 (61.3)317 (64.2)Adenocarcinoma770 (66.5)321 (63.8)303 (61.3)317 (64.2)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Central	127 (11.0)	75 (14.9)		69 (14.0)	70 (14.2)	
Smoking history       0.528       0.628       0.848         Never       549 (47.4)       230 (45.7)       223 (45.1)       226 (45.7)         Current/former       609 (52.6)       273 (54.3)       271 (54.9)       268 (54.3)         Comorbidity       0.981       0.981       0.949         No       574 (49.6)       249 (49.5)       243 (49.2)       244 (49.4)         Yes       584 (50.4)       254 (50.5)       251 (50.8)       250 (50.6)         Surgical approach       0.590       250 (50.6)       0.593         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Lobectomy       91 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)         Bilobectomy       136 (11.7)       74 (14.7)       77 (15.6)       73 (14.8)         Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       136 (61.3)         Histology       0.21 (65.5)       3	Peripheral	1031 (89.0)	428 (85.1)		425 (86.0)	424 (85.8)	
Never         549 (47.4)         230 (45.7)         223 (45.1)         226 (45.7)           Current/former         609 (52.6)         273 (54.3)         271 (54.9)         268 (54.3)           Comorbidity         0.981         0.981         0.949           No         574 (49.6)         249 (49.5)         243 (49.2)         244 (49.4)           Yes         584 (50.4)         254 (50.5)         251 (50.8)         250 (50.6)           Surgical approach         0.590         0.590         0.458           Thoracotomy         851 (73.5)         376 (74.8)         379 (76.7)         369 (74.7)           Thoracoscopic         307 (26.5)         127 (25.2)         115 (23.3)         125 (25.3)           Surgical resection         0.055         0.921         0.921           Lobectomy         991 (85.6)         408 (81.1)         398 (80.6)         403 (81.6)           Bilobectomy         136 (11.7)         74 (14.7)         77 (15.6)         73 (14.8)           Pneumonectomy         31 (2.7)         21 (4.2)         19 (3.8)         18 (3.6)           Histology         0.213         0.223         0.213         0.213           Adenocarcinoma         770 (66.5)         321 (63.8)         303 (61.3)	Smoking history			0.528			0.848
Current/former609 (52.6)273 (54.3)271 (54.9)268 (54.3)Comorbidity0.9810.9810.941No574 (49.6)249 (49.5)243 (49.2)244 (49.4)Yes584 (50.4)254 (50.5)251 (50.8)250 (50.6)Surgical approach0.5900.590250 (50.6)Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracoscopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection0.0550.0550.921Lobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (63.8)303 (61.3)317 (64.2)Histology0.0230.0230.561Adenocarcinoma317 (27.4)132 (26.2)143 (28.9)128 (25.9)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Never	549 (47.4)	230 (45.7)		223 (45.1)	226 (45.7)	
Comorbidity $0.981$ $0.949$ No $574$ (49.6) $249$ (49.5) $243$ (49.2) $244$ (49.4)         Yes $584$ (50.4) $254$ (50.5) $251$ (50.8) $250$ (50.6)         Surgical approach $0.590$ $0.590$ $0.590$ $0.458$ Thoracotomy $851$ (73.5) $376$ (74.8) $379$ (76.7) $369$ (74.7)         Thoracoscopic $307$ (26.5) $127$ (25.2) $115$ (23.3) $125$ (25.3)         Surgical resection $0.991$ (85.6) $408$ (81.1) $398$ (80.6) $403$ (81.6) $0.921$ Iobectomy $991$ (85.6) $408$ (81.1) $398$ (80.6) $403$ (81.6) $0.921$ Bilobectomy $316$ (11.7) $74$ (14.7) $77$ (15.6) $73$ (14.8) $0.91$ Histology $31$ (2.7) $21$ (4.2) $19$ (3.8) $18$ (3.6) $0.561$ Adenocarcinoma $770$ (66.5) $321$ (63.8) $303$ (61.3) $317$ (64.2) $143$ (28.9) $128$ (25.9)         Others $71$ (6.1) $50$ (9.9) $48$ (9.7) $49$ (9.9) $106$	Current/former	609 (52.6)	273 (54.3)		271 (54.9)	268 (54.3)	
No574 (49.6)249 (49.5)243 (49.2)244 (49.4)Yes584 (50.4)254 (50.5)251 (50.8)250 (50.6)Surgical approach0.5900.5900.458Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracoscopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection0.0550.921Lobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (4.2)19 (3.8)18 (3.6)Histolgy0.0230.0230.551Adenocarcinoma770 (66.5)321 (63.8)303 (61.3)317 (64.2)Quamous cell carcinoma317 (27.4)132 (26.2)143 (28.9)128 (25.9)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Comorbidity			0.981			0.949
Yes       584 (50.4)       254 (50.5)       251 (50.8)       250 (50.6)         Surgical approach       0.590       0.458         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracoscopic       307 (26.5)       127 (25.2)       115 (23.3)       125 (25.3)         Surgical resection       991 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)         Bilobectomy       991 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)         Pneumonectomy       136 (11.7)       74 (14.7)       77 (15.6)       73 (14.8)         Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       18 (3.6)         Histology       70 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Quamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	No	574 (49.6)	249 (49.5)		243 (49.2)	244 (49.4)	
Surgical approach       0.590       0.458         Thoracotomy       851 (73.5)       376 (74.8)       379 (76.7)       369 (74.7)         Thoracoscopic       307 (26.5)       127 (25.2)       115 (23.3)       125 (25.3)       0.921         Surgical resection       0.055       0.055       0.921       0.921         Lobectomy       991 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)       0.921         Bilobectomy       136 (11.7)       74 (14.7)       77 (15.6)       73 (14.8)       0.651         Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       18 (3.6)       0.561         Histology       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)       0.561         Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       128 (25.9)       0.561         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)       128 (25.9)       128 (25.9)	Yes	584 (50.4)	254 (50.5)		251 (50.8)	250 (50.6)	
Thoracotomy851 (73.5)376 (74.8)379 (76.7)369 (74.7)Thoracoscopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection0.0550.0550.921Lobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (4.2)19 (3.8)18 (3.6)Histology770 (66.5)321 (63.8)303 (61.3)317 (64.2)Adenocarcinoma770 (66.5)321 (63.8)303 (61.3)128 (25.9)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Surgical approach			0.590			0.458
Thoracoscopic307 (26.5)127 (25.2)115 (23.3)125 (25.3)Surgical resection0.0550.921Lobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (4.2)19 (3.8)18 (3.6)Histology0.0230.5610.561Adenocarcinoma770 (66.5)321 (63.8)303 (61.3)317 (64.2)Squamous cell carcinoma317 (27.4)132 (26.2)143 (28.9)128 (25.9)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Thoracotomy	851 (73.5)	376 (74.8)		379 (76.7)	369 (74.7)	
Surgical resection       0.055       0.921         Lobectomy       991 (85.6)       408 (81.1)       398 (80.6)       403 (81.6)         Bilobectomy       136 (11.7)       74 (14.7)       77 (15.6)       73 (14.8)         Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       18 (3.6)         Histology       0.023       0.023       0.561         Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Squamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	Thoracoscopic	307 (26.5)	127 (25.2)		115 (23.3)	125 (25.3)	
Jobectomy991 (85.6)408 (81.1)398 (80.6)403 (81.6)Bilobectomy136 (11.7)74 (14.7)77 (15.6)73 (14.8)Pneumonectomy31 (2.7)21 (4.2)19 (3.8)18 (3.6)Histology0.0230.0230.561Adenocarcinoma770 (66.5)321 (63.8)303 (61.3)317 (64.2)Squamous cell carcinoma317 (27.4)132 (26.2)143 (28.9)128 (25.9)Others71 (6.1)50 (9.9)48 (9.7)49 (9.9)	Surgical resection			0.055			0.921
Bilobectomy       136 (11.7)       74 (14.7)       77 (15.6)       73 (14.8)         Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       18 (3.6)         Histology       0.023       0.561         Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Squamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	Lobectomy	991 (85.6)	408 (81.1)		398 (80.6)	403 (81.6)	
Pneumonectomy       31 (2.7)       21 (4.2)       19 (3.8)       18 (3.6)         Histology       0.023       0.561         Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Squamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	Bilobectomy	136 (11.7)	74 (14.7)		77 (15.6)	73 (14.8)	
Histology       0.023       0.561         Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Squamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	Pneumonectomy	31 (2.7)	21 (4.2)		19 (3.8)	18 (3.6)	
Adenocarcinoma       770 (66.5)       321 (63.8)       303 (61.3)       317 (64.2)         Squamous cell carcinoma       317 (27.4)       132 (26.2)       143 (28.9)       128 (25.9)         Others       71 (6.1)       50 (9.9)       48 (9.7)       49 (9.9)	Histology			0.023		. ,	0.561
Squamous cell carcinoma         317 (27.4)         132 (26.2)         143 (28.9)         128 (25.9)           Others         71 (6.1)         50 (9.9)         48 (9.7)         49 (9.9)	Adenocarcinoma	770 (66.5)	321 (63.8)		303 (61.3)	317 (64.2)	
Others 71 (6.1) 50 (9.9) 48 (9.7) 49 (9.9)	Squamous cell carcinoma	317 (27.4)	132 (26.2)		143 (28.9)	128 (25.9)	
	Others	71 (6.1)	50 (9.9)		48 (9.7)	49 (9.9)	

(Continues)

#### TABLE 1 (Continued)

	Entire cohort (N = 1661)			Propensity score ma	Propensity score matching ( $N = 988$ )	
Characteristics	Without 3A LND ( <i>N</i> = 1158)	With 3A LND ( <i>N</i> = 503)	p	Without 3A LND ( <i>N</i> = 494)	With 3A LND ( <i>N</i> = 494)	Þ
Cell differentiation			0.495			0.949
Well	76 (6.6)	34 (6.8)		32 (6.5)	34 (6.9)	
Moderate	477 (41.2)	187 (37.2)		191 (38.7)	184 (37.2)	
Poor	539 (46.5)	251 (49.9)		238 (48.2)	245 (49.6)	
NA	66 (5.7)	31 (6.2)		33 (6.7)	31 (6.3)	
Tumor size (cm)			0.164 <sup>a</sup>			0.869 <sup>a</sup>
$Mean \pm SD$	$3.6\pm2.0$	$3.8\pm2.1$		$3.7\pm2.0$	$3.8\pm2.1$	
Median (min., max.)	3.0 (0.5, 14.0)	3.0 (0.3, 13.0)		3.0 (0.5, 14.0)	3.0 (0.3, 13.0)	
Adjuvant therapy			0.220			0.949
No	657 (56.7)	269 (53.5)		263 (53.2)	262 (53.0)	
Yes	501 (43.3)	234 (46.5)		231 (46.8)	232 (47.0)	
Complication			0.920			0.533
No	1079 (93.2)	468 (93.0)		457 (92.5)	462 (93.5)	
Yes	79 (6.8)	35 (7.0)		37 (7.5)	32 (6.5)	
No. of resected TLNs			<0.001 <sup>a</sup>			0.688 <sup>a</sup>
$Mean \pm SD$	$22.3\pm10.0$	$25.0\pm11.2$		$24.8\pm10.8$	$24.7\pm10.9$	
Median (min, max)	21.0 (4, 84)	23.0 (5, 78)		23.0 (4, 77)	23.0 (5, 78)	
No. of resected MLNs			<0.001 <sup>a</sup>			0.478 <sup>a</sup>
$Mean \pm SD$	$15.0\pm7.7$	$17.7\pm8.5$		$17.3\pm8.7$	$17.4\pm8.0$	
Median (min, max)	14.0 (3, 60)	17.0 (3, 67)		16.0 (3, 55)	16.0 (3, 52)	
Drainage of POD1 (ml)			0.041			0.145
$Mean \pm SD$	$481.3\pm238.4$	$516.1\pm281.5$		$484.3\pm231.9$	$515.9\pm282.7$	
Median (min, max)	460.0 (0, 2410)	500.0 (0, 2710)		460.0 (0, 1450)	500.0 (0, 2710)	
Hospital stays (days)			0.851			0.239
Mean $\pm$ SD	$10.2\pm 6.2$	$12.5\pm29.3$		$10.7\pm 6.8$	$10.0\pm5.3$	
Median (min, max)	9.0 (2, 89)	9.0 (1, 379)		9.0 (2, 79)	9.0 (3, 65)	

Abbreviations: LND, lymph node dissection; SD, standard deviations; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; NA, not available, TLNs, total lymph nodes; MLNs, mediastinal lymph nodes; POD1, postoperative day 1.

<sup>a</sup>Mann–Whitney U test.

#### Statistical analysis

Continuous variables were compared between groups by the Mann-Whitney U-test. The Pearson  $\chi^2$  test was used to determine significant differences between groups for categorical variables. Univariate and multivariate logistic regression models were used to reveal the clinical factors associated with station 3A LNM. The variates whose p < 0.15in the univariate logistic regression model were further included in the multivariate logistic regression model. Overall survival (OS) is the time between the date of surgery and the date of death. Disease-free survival (DFS) is the time from surgery until recurrence or death from any cause. The Kaplan-Meier method was used to assess OS and DFS. The log-rank test was used to compare the differences in OS and DFS between groups. The Cox proportional hazards regression model was used to determine independent prognostic factors impacting OS and DFS. IBM SPSS Statistics (version

25.0, IBM Corp.) was used to conduct all statistical analyses. Two-sided p < 0.05 was considered statistically significant.

#### RESULTS

#### Patient characteristics

A total of 1661 patients were included in this study, and 494 pairs were successfully matched. The clinicopathological characteristics for both the entire cohort and matched cohorts are summarized in Table 1. For the entire cohort, 30.3% (503/1661) of patients underwent 3A LND. Patients with 3A LND were more likely to be older (p = 0.003), have pathological N2 disease (p = 0.004), have tumors in the middle lobes (p = 0.021), present other pathological types than adenocarcinoma or squamous cell carcinoma (p = 0.023), present central-type NSCLC (p = 0.024), have

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more drainage on postoperative day 1 (p = 0.041), and have more lymph nodes harvested (p < 0.001) (Table 1). Other clinicopathological characteristics were well balanced between groups. After PSM, all of the clinicopathological characteristics were comparable between the 3A LND<sup>+</sup> group and the 3A LND<sup>-</sup> group (Table 1).

# Assessment of mediastinal lymph node metastases

As predicted, station 4R (17.1%, 233/1365; Table 2) lymph nodes were most likely to metastasize throughout the entire cohort, but the metastasis rate of station 3A lymph nodes was also as high as 11.3% (57/503) for the entire cohort. The most common sites of MLNM for tumors in the right upper lobe (RUL), right middle lobe (RML), and right lower lobe (RLL) were station 4R (21.6%, 160/742), station 7 (22.0%, 45/205), and station 7 (23.2%, 134/578) lymph nodes, respectively (Table 2). RUL and RML tumors were more likely to have upper zone (station 2R/3A/4R) MLNM than RLL tumors (p < 0.001; Table 2). RLL tumors were more likely to have lower zone (station 8/9) MLNM than tumors in other lobes (p < 0.001; Table 2). It is not surprising that RML and RLL tumors had a significantly higher rate of station 7 MlNM than RUL tumors (p < 0.001; Table 2).

Furthermore, we calculated the single-station MLNM rate for each station in all patients with N2 disease. As Supporting Information Table S1, online only) shows, the incidence of single station 3A LNM was only 3.0% (13/436), which was much lower than that of station 2R (9.9%, 43/436), station 4R (20.2%, 88/436), and station 7 (22.2%,

**TABLE 2** Occurrence and distribution of MLNM by lymph node stations and zones for the entire cohort stratified by tumor location (*N* = 1661)

	Lymph node metastatic rate % (involved/resected)				
Stations/zones	Total	RUL	RML	RLL	p
Station 2R	11.6 (176/1516)	13.2 (108/817)	13.0 (24/184)	8.5 (44/515)	0.028
Station 3A	11.3 (57/503)	12.7 (33/259)	17.7 (14/79)	6.1 (10/165)	0.016
Station 4R	17.1 (233/1365)	21.6 (160/742)	14.6 (25/171)	10.6 (48/452)	< 0.001
Station 7 (SC zone)	12.5 (208/1661)	3.3 (29/878)	22.0 (45/205)	23.2 (134/578)	< 0.001
Station 8	3.7 (7/189)	1.2 (1/86)	0 (0/20)	7.2 (6/83)	0.045 <sup>a</sup>
Station 9	4.5 (35/780)	0.8 (3/377)	2.8 (2/72)	9.1 (30/331)	< 0.001
Upper zone	19.1 (316/1651)	23.8 (208/873)	20.5 (42/205)	11.5 (66/573)	< 0.001
Lower zone	4.6 (40/877)	1.0 (4/420)	2.3 (2/88)	9.2 (34/369)	< 0.001

Abbreviations: MLNM, mediastinal lymph node metastasis; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe. <sup>a</sup>Fisher's exact test.



**FIGURE 1** Survival curves for patients with and without station 3A lymph node dissection (LND) before propensity score matching: (a) overall survival (OS) and (b) disease-free survival (DFS)

#### **TABLE 3** Multivariate Cox regression analyses for prognostic factors before propensity score matching (N = 1661)

os

DFS

Characteristics	HR (95% CI)	p	HR (95% CI)	p
Sex				
Male	Ref		Ref	
Female	0.859 (0.664–1.111)	0.247	0.924 (0.737-1.160)	0.497
Age (years)				
≤60	Ref		Ref	
>60	1.369 (1.153–1.625)	< 0.001	1.190 (1.019–1.389)	0.028
Tumor location				
RUL	Ref		Ref	
RML	1.231 (0.939–1.613)	0.133	1.106 (0.865–1.415)	0.422
RLL	1.222 (1.011–1.477)	0.038	1.187 (1.002–1.405)	0.048
Anatomical type				
Central	Ref		Ref	
Peripheral	0.785 (0.611-1.010)	0.059	0.852 (0.673-1.079)	0.184
Smoking history				
Never	Ref		Ref	
Current/Former	1.314 (1.040–1.659)	0.022	1.336 (1.083–1.648)	0.007
Comorbidity				
No	Ref		Ref	
Yes	0.892 (0.754–1.054)	0.180	1.012 (0.870-1.178)	0.877
Surgical resection				
Lobectomy	Ref		Ref	
Bilobectomy	0.983 (0.760-1.272)	0.898	1.056 (0.836-1.335)	0.646
Pneumonectomy	0.869 (0.559–1.351)	0.532	0.888 (0.582-1.355)	0.581
Histology				
Adenocarcinoma	Ref		Ref	
Squamous cell carcinoma	0.792 (0.643–0.976)	0.028	0.678 (0.558-0.824)	< 0.001
Others	0.840 (0.601–1.174)	0.308	0.843 (0.622-1.142)	0.270
Cell differentiation				
Well	Ref		Ref	
Moderate	1.328 (0.851-2.072)	0.212	1.415 (0.954–2.097)	0.084
Poor	1.817 (1.170–2.820)	0.008	1.608 (1.086-2.381)	0.018
NA	1.384 (0.780–2.457)	0.267	1.349 (0.815-2.231)	0.244
Adjuvant therapy				
No	Ref		Ref	
Yes	0.814 (0.677–0.978)	0.028	0.978 (0.830-1.153)	0.793
Pathological T category				
T1	Ref		Ref	
T2	1.419 (1.143–1.761)	0.001	1.351 (1.117–1.634)	0.002
T3	2.072 (1.593-2.694)	< 0.001	2.012 (1.586-2.552)	< 0.001
T4	2.078 (1.489-2.899)	< 0.001	1.904 (1.404–2.583)	< 0.001
Pathological N category				
N0	Ref		Ref	
N1	1.477 (1.120–1.947)	0.006	1.559 (1.224–1.987)	< 0.001
N2	2.755 (2.259–3.360)	< 0.001	2.400 (2.005–2.872)	< 0.001
Postoperative complications				
No	Ref		Ref	
Yes	1.221 (0.908–1.643)	0.187	1.208 (0.918-1.590)	0.177
				(Continues)

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#### TABLE 3 (Continued)

	OS		DFS		
Characteristics	HR (95% CI)	P	HR (95% CI)	p	
No. of resected N1 LNs	1.003 (0.985-1.022)	0.732	1.005 (0.988-1.022)	0.555	
No. of resected N2 LNs	0.995 (0.985–1.006)	0.361	0.992 (0.982-1.001)	0.093	
3A dissection					
3A LND <sup>-</sup>	Ref		Ref		
3A LND <sup>+</sup>	1.214 (1.016–1.452)	0.033	1.162 (0.988–1.367)	0.070	

Abbreviations: OS, overall survival; DFS, disease-free survival; HR, hazard ratio; CI, confidence interval; Ref, reference; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; NA, not available; LND, lymph node dissection.



**FIGURE 2** Survival curves for patients with and without station 3A lymph node dissection (LND) after propensity score matching: (a) overall survival (OS) and (b) disease-free survival (DFS)

97/436) LNM. Moreover, in 57 patients with station 3A LNM, 44 patients (77.2%) showed multistation MLNM and only 13 patients (22.8%) did not show MLNM in other stations.

station 7 LNM (OR = 8.783, 95% CI, 1.933–39.907, p = 0.005), and the number of examined N2 lymph nodes (OR = 0.895, 95% CI, 0.817–0.982, p = 0.019) were all independent risk factors associated with station 3A LNM (Supporting Information Table S2, online only).

#### **Risk factors for station 3A LNM**

To identify the risk factors influencing station 3A LNM, we performed univariate and multivariate logistic regression models. As showed in Supporting Information Table S2 (online only), a univariate logistic model found that tumor location, surgical approach, station 2R/4R/7/8/9/10 LNM, the number of examined N2 stations, and the number of examined N2 lymph nodes were associated with station 3A LNM. The multivariate logistic model further confirmed that tumor location (RML: odds ratio [OR] = 6.442, 95% confidence interval [CI], 1.315–31.569, p = 0.022), station 4R LNM (OR = 33.544, 95% CI, 6.728–167.233, p < 0.001),

#### Survival comparison

Before PSM, it was surprising that patients with 3A LND had a significantly worse OS (5-year OS 70.1% vs. 63.1%, p = 0.002; Figure 1a) and DFS (5-year DFS 61.7% vs. 55.7%, p = 0.011; Figure 1b) than those without 3A LND. Multivariate analysis suggested that 3A LND was an independent factor associated with worse OS (hazard ratio [HR] = 1.214, 95% CI, 1.016–1.452, p = 0.033; Table 3) but not DFS (HR = 1.162, 95% CI, 0.988–1.367, p = 0.070; Table 3).

After PSM, however, the 5-year OS rates (3A LND<sup>-</sup> group vs. 3A LND<sup>+</sup> group 65.7% vs. 63.6%, p = 0.432;

### **T A B L E 4**Multivariate Cox regression analyses for prognostic factors after propensity score matching (N = 988)

CharacteristicsIIR (99% CI)PIIR (99% CI)PSetSetMaleRefSet0579 (0.709-1.588)0.8990576 (0.729-1.318)0.871Age (year)SetRefSetSet0.576 (0.729-1.318)0.871Age (year)SetRefSetSet0.576 (0.729-1.318)0.141Tumor heatineRefRefSet0.576 (0.729-1.518)0.515Ruth1.320 (0.930-1.751)0.1311.090 (0.812-1.463)0.505Ruth1.320 (0.927-1.671)0.0311.020 (0.927-1.572)0.521Autorical typeFRefSet0.520 (0.927-1.572)Carter Urage0.722 (0.51-0.921)0.0210.518 (1.166-2.033)0.020SnakerSetSet (1.12-2.561)0.0221.554 (1.166-2.033)0.020Carter UrageRefRefSet (1.166-2.033)0.020Carter UrageNoRefSet (1.166-2.033)0.020SnakerSet (1.12-2.561)0.0211.554 (1.166-2.033)0.020Carter UrageRefSet (1.167-1.03)0.0210.021SnakerSet (1.167-1.253)0.0211.554 (1.167-1.03)0.020SnakerSet (1.167-1.138)0.0210.0210.021SnakerSet (0.167-1.031)0.0370.0370.037SnakerSet (0.167-1.031)0.0370.0310.037SnakerSet (0.167-1.031)0.0310.0310.031SnakerSet (0.1		OS		DFS		
Ser         Ref         Ref         Ref           Male         9.79 (0.700-1.368)         0.899         0.976 (0.722-1.316)         0.871           Age (years)	Characteristics	HR (95% CI)	p	HR (95% CI)	р	
MaleRefRefFormale0.990 (0.703-1.360)0.8900.950 (0.723-1.316)0.817Age (years)RefRef>601.650 (1.992-1.413)0.0061.160 (1.992-1.413)0.111Tumor locationRefRefRULRefMefSet0.006 (1.912-1.403)0.585RUL1.270 (1.929-1.573)0.0301.225 (1.982-1.527)0.072Anatomical TypeRefCentralRefRef0.026 (1.929-1.927)0.072Anatomical TypeRefCentral (Set (1.927-1.629)0.0130.831 (0.624-1.106)0.204Smoking History1.921 (0.824-1.026)0.002Concertu/former0.657 (1.21-2.69)0.0021.854 (1.164-2.033)0.002Concertu/formerRefRefNo0.0020.002Concertu/former0.660 (6.69-1.061)0.1590.214 (0.854-1.242)0.860Singelar resctinRefNo0.0010.0020.002Concertu/former0.840 (0.69-1.049)0.0070.650 (0.89-0.149)0.001NoRefRefNo0.0020.0020.002Signamous coll carchoma0.670 (0.57-0.901)0.0020.0020.002Othera0.830 (0.21-1.285)0.5120.921 (0.66-1.283)0.626Coll carchoma0.670 (0.57-0.901)0.0010.0020.002Othera0.830 (0.21-1.285)0.012<	Sex					
Fende0.979 (0.700-1.368)0.9990.976 (0.723-1.316)0.871Age (vars)KefKef>601.354 (1.090-1.681)0.0061.160 (0.952-1.413)0.141Tumor locationKefKefKefRULRefKefKefRUL1.310 (0.272-1.671)0.0301.225 (0.982-1.527)0.055RLI1.310 (0.272-1.671)0.0300.831 (0.624-1.06)0.201Anatomical typeKefKefPerepheralControlRefKef0.0020.002Smoking hitroy0.0021.518 (1.64-0.033)0.002Control/formerRef (1.164-0.033)0.0020.0020.002Control/formerRef (1.164-0.033)0.0020.0020.002Control/formerRef (1.164-0.033)0.0020.0020.002Control/formerRef (1.164-0.033)0.0020.0020.002Control/formerRef (1.164-0.033)0.0020.0020.002Surgical resectionKefKef0.0010.001AdenoarcinomaRefKef0.0010.0020.002Coll differentionRef (1.164-0.123)0.0110.0210.0210.021AdenoarcinomaRefKef0.0010.0210.0210.021AdenoarcinomaRefKef0.0010.0210.0210.0210.0210.0210.0210.0210.0210.0210.0210.0210.0210.0210.0210.021	Male	Ref		Ref		
Age (years)         Kef         Kef           560         Ref         Kef           560         Ref         Lass           560         Ref         Lass           Tumor location         Kef         Kef           RUL         Ref         Kef           RMI.         1.270 (9.90-1.754)         0.331         L900 (0.872-1.463)         0.585           RL         1.310 (1.027-1.671)         0.300         L225 (0.982-1.527)         0.072           Anatomical type         Cararal         Ref         Kef         0.204           Sonking thiory         Kef         Kef         0.204           Sonking thiory         No         Ref         Kef         0.204           Sonking         Kef         Kef         0.204         0.002         1.548 (1.166-2.053)         0.002           Corrent/Former         Ref         Kef         Kef         0.204         0.801         0.002         1.548 (1.166-2.053)         0.002           Sonking thiory         Kef         Kef         Kef         0.204         0.806         0.801         0.801         0.801         0.801         0.801         0.801         0.801         0.801         0.801         0.801	Female	0.979 (0.700-1.368)	0.899	0.976 (0.723-1.316)	0.871	
se6         Ref         Ref           3:60         1.354 (1.090-1.681)         0.006         1.160 (0.952-1.413)         0.141           Tumor becution         Ref         Ref         Ref         Ref           RUI.         Ref         Ref         Ref         Ref         Ref         0.900 (0.812-1.403)         0.565           RLL         1.310 (1.027-1.671)         0.030         0.331 (0.624-1.106)         0.204           Cantral         Ref         Ref         Ref         0.230 (0.624-1.066)         0.204           Smaling hatory         U         Ref         0.230 (0.624-1.066)         0.204           Smaling hatory         Ref         Ref         0.202           Courrent/Former         Ref (0.101-0.203)         0.002         0.548 (0.166-2.053)         0.002           Countrality         Ref         Ref         0.002         0.548 (0.686-1.242)         0.806           Sugial resection         Ref         Ref         0.337 (0.331 (0.624-1.242)         0.806           Sugial resection         Ref         Ref         0.338         0.316 (0.321-1.243)         0.318           Histology         U         0.303 (0.521-1.326)         0.521 (0.80-1.2423)         0.201	Age (years)					
>601.534 (1.090-1.681)0.0061.160 (0.952-1.413)0.141Tumor locationRfRfRUT.RefRfRMI.1.207 (0.930-1.734)0.1311.090 (0.812-1.463)0.565RLI.1.207 (0.930-1.761)0.0301.225 (0.982-1.527)0.072Anatomical typeCartralRefRefPeripheral0.20 (0.941-0.991)0.0430.831 (0.62-1.106)0.204Smoking historyNeverRefRefCartral former1.677 (1.211-2.269)0.0021.548 (1.166-2.053)0.002CamorbidityNeverRefRefStocamorbidity1.037 (1.211-2.269)0.0120.248 (0.645-1.242)0.806Singcal resctionLLNo.204 (0.845-1.242)0.806Singcal resctionLRefRefNo.204 (0.845-1.242)0.806Singcal resctionLNo.909 (0.809-1.408)0.5080.809 (0.809-1.407)0.557PhezumoactarinomaRef of 0.901 (0.370-0.904)0.0070.623 (0.489-0.799)0.001Others0.893 (0.621-1.285)0.5420.921 (0.661-1.283)0.626Call differentistionWellRefRefNoWellRefRefNoNo0.0070.637 (0.473-0.4010.637 (0.473-0.402)0.208NoRefNo1.397 (0.771-1.835)0.1150.0011.383 (1.061-1.273)0.011NoNoStol (0.677-1.071)0.310 (0.610-1.273)0.0011.353 (1.061-1.771 <td>≤60</td> <td>Ref</td> <td></td> <td>Ref</td> <td></td>	≤60	Ref		Ref		
Tumor location         Ref         Ref           RUL         Ref         Ref           RUL         1.27 (0.930–1.754)         0.131         1.090 (0.812-1.463)         0.525           RIL         1.31 (1.027–1.671)         0.030         0.225 (0.982–1.527)         0.072           Anatomical type         E         Ref         Perphenal         0.223 (0.511–0.991)         0.043         0.811 (0.624–1.106)         0.204           Smoking hybory         Ref         Ref         Control/former         1.537 (1.211-2.269)         0.002         1.548 (1.166–2.053)         0.002           Comorbidity         Ref         Ref         Secondational transmissional t	>60	1.354 (1.090–1.681)	0.006	1.160 (0.952–1.413)	0.141	
KU1.RefRefKN1.1.277 (0.930-1.754)0.1311.990 (0.81-1.463)0.565KL11.310 (0.27-1.671)0.0301.225 (0.982-1.527)0.072Antomical typeRefCentralRefRefPeripheral0.722 (0.541-0.91)0.0430.831 (0.624-1.06)0.204Sanding hixtoryRefNeverRefRefCurrent/Former0.860 (0.899-1.661)0.190.1024 (0.851-1242)0.806Sorgical resctonRefIbiobectomyRefRefBiobectomy0.860 (0.599-1.061)0.9351.899 (0.820-1.447)0.537Pareumoctomy0.490 (0.501-1.408)0.5080.899 (0.820-1.417)0.537Biobectomy0.893 (0.621-1.283)0.5420.921 (0.651-1.283)0.626Cell differnitationRefWellRefRefModerateCell (0.571-0.931)0.3181.517 (0.937-2.549)0.115Poor0.933 (0.621-1.283)0.5420.921 (0.661-1.283)0.626Cell differnitationRefWellRefRefModerate1.299 (0.761-2.323)0.3181.517 (0.372-1.86)0.201NA1.495 (0.771-1.07)0.1041.353 (1.064-1.717)0.014Na1.495 (0.771-1.85)0.014 <t< td=""><td>Tumor location</td><td>× ,</td><td></td><td>· · · · ·</td><td></td></t<>	Tumor location	× ,		· · · · ·		
RML1.277 (0.930-1.754)0.1311.090 (0.812-1.453)0.565RL1.310 (1.027-1.671)0.0301.225 (0.982-1.527)0.072Anatomical typeKefRefCentralRefRef0.204SmokingNeverRefRef0.0430.811 (0.624-1.106)0.204SmokingNeverRefRefRef0.0021.548 (1.166-2.053)0.002Contral former1.657 (1.211-2.269)0.0021.548 (1.166-2.053)0.002Contral formerRefRefRefRefRefYes0.360 (0.698-1.061)0.1591.024 (0.845-1.242)0.806Sugilar feactionRefRefRefRefIbiobectomyRefRefRefRefSugilar feactionRefRefRefRefJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyCal differentionRefRefRefJustolagyJustolagyUationagyRefRefRefJustolagyJustolagyJustolagyJustolagyUationagyRefRefRefJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyRefJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyJustolagyRefRefRefRefRefRefJustolagyJustolagyJustolagyJusto	RUL	Ref		Ref		
ILI.1.310 (1.027-1.671)0.0301.225 (0.982-1.527)0.072Anatomical typeCentralRefPeripheral0.72 (0.511-0.921)0.430.831 (0.624-1.100)0.204Smoking historyRefNeverRefRefCorrent/Former1.657 (1.211-2.269)0.0021.548 (1.166-2.053)0.002Corrent/Former0.657 (1.211-2.269)0.0021.548 (1.166-2.053)0.002Corrent/Former1.657 (1.211-2.269)0.0021.548 (1.166-2.053)0.002Corrent/Former0.650 (0.698-1.061)0.5930.819 (0.495-1.242)0.806Sugical resctionRefInconcentomy0.800 (0.698-1.061)0.9350.891 (0.820-1.447)0.557Paeumonechy0.840 (0.501-1.408)0.5080.871 (0.532-1.426)0.537Paeumonechy0.840 (0.501-1.408)0.5080.871 (0.532-1.426)0.501Supamous cell carcinomaRefRefSquamous cell carcinomaRefRefModerate1.359 (0.761-2.323)0.0171.517 (0.903-2.549)0.115Poor1.957 (1.128-3.393)0.0171.513 (1.049-1.366)0.021NANA (0.507-1.071)0.7100.961 (0.779-1.186)0.712Pathogical T categoryRefRefTRefRefTANA (0.6071-0.713)0.0141.552 (1.064-1.717)0.014 <t< td=""><td>RML</td><td>1.277 (0.930-1.754)</td><td>0.131</td><td>1.090 (0.812-1.463)</td><td>0.565</td></t<>	RML	1.277 (0.930-1.754)	0.131	1.090 (0.812-1.463)	0.565	
Alatomical type         Kef         Ref           Control         Kef         Kef           Peripheral         0.30 (0.541-0.091)         0.043         0.831 (0.624-1.100)         0.204           Smoking History         Ker         Kef         Kef         Kef           Comorbidity         Kef         Kef         0.002         0.510 (0.62-0.531)         0.002           Comorbidity         Kef	RLL	1.310 (1.027–1.671)	0.030	1.225 (0.982–1.527)	0.072	
Central         Ref         Ref           Peripheral         0.732 (0.541–0.991)         0.043         0.331 (0.624–1.106)         0.204           Smoking history            0.602         0.548 (1.166–2.053)         0.002           Current/Former         1.657 (1.211–2.269)         0.002         1.548 (1.166–2.053)         0.002           Comorbidity          Ref         Ref         0.600         0.6098–1.061)         0.159         1.024 (0.845–1.242)         0.806           Surgical resection          Ref         Ref         0.800         0.6098–1.061)         0.503         0.871 (0.532–1.426)         0.583           Bilobectomy         0.103 (0.745–1.376)         0.935         1.089 (0.820–1.447)         0.557           Pneumonectomy         0.840 (0.501–1.408)         0.508         0.871 (0.532–1.426)         0.583           History          1.013 (0.745–1.376)         0.512         0.921 (0.661–1.233)         0.626           Squamous cell carcinoma         Ref         Ref         Squamous cell carcinoma         Squamous cell carcinoma         1.957 (1.128–3.393)         0.017         1.831 (1.094–3.066)         0.021           Orbers         0.893 (0.671–0.71)         0.710         0.9061	Anatomical type					
Peripheral0.732 (0.541-0.991)0.0430.831 (0.624-1.06)0.204Smoking historyNeverRefRefCorrent/Former1.657 (1.211-2.29)0.0021.548 (1.166-2.053)0.002ComorbidityNoRefRefYes0.806 (0.698-1.061)0.1021.548 (1.166-2.053)0.002ComorbidityNoRefRefSurgical reactionRefRef1.002LobectomyRefRef1.002Bioboctomy1.013 (0.745-1.376)0.9351.089 (0.820-1.447)0.557Pneumonectomy0.804 (0.501-1.408)0.0370.025 (0.489-0.799)<0.011	Central	Ref		Ref		
Smoking history         Notice         Ref           Never         Ref         Ref           Current/Former         1.657 (1211-2.269)         0.002         1.548 (1.166-2.053)         0.002           Comorbidity         Image: Comorbidity	Peripheral	0.732 (0.541-0.991)	0.043	0.831 (0.624–1.106)	0.204	
Never         Ref         Ref           Current/Former         1.657 (1.211-2.269)         0.002         1.548 (1.166-2.053)         0.002           Comorbidity         No         Ref         Kef         No         No         No         Ref         No         No         Ref         No         No         Ref         No         No         Ref         No         No         No         Ref         No         No         No         Ref         No         No         No         Ref         No	Smoking history					
Current/Former         1.657 (1211-2.269)         0.002         1.548 (1.166-2.053)         0.002           Comorbidity         No         Ref         Kef           No         Ref         Differentiation         Ref           Yes         0.660 (6.088-1.061)         0.159         D.404 (0.045-1.242)         0.806           Surgical resection         Kef         Ref         Set         D.559         D.809 (0.820-1.447)         0.557           Pneumonectomy         0.804 (0.501-1.408)         0.508         0.871 (0.532-1.426)         0.583           Histoley         Nationa (0.507 (0.537-0.904)         0.007         0.526 (0.489-0.799)         <0.001	Never	Ref		Ref		
Comorbidity         No         Ref         Ref           No         Ref         Ref         0.024 (0.845–1.242)         0.806           Surgical resection         Lobectomy         Ref         Ref           Bilobectomy         Ref         Ref         0.0353         1.089 (0.820–1.447)         0.557           Pneumonectomy         0.840 (0.501–1.408)         0.508         0.871 (0.532–1.426)         0.583           Histolog	Current/Former	1.657 (1.211–2.269)	0.002	1.548 (1.166-2.053)	0.002	
No         Ref         Ref           Yes         0.860 (0.698-1.061)         0.159         1.024 (0.845-1.242)         0.806           Surgial resection           Kef           0.806         0.806         0.806         0.806         0.806         0.806         0.806         0.807         0.637         0.808         0.807         0.537         Decotomy         0.610 (0.745-1.376)         0.935         0.898 (0.820-1.447)         0.537           Pneumoectomy         0.640 (0.501-1.408)         0.508         0.871 (0.532-1.426)         0.583           Histology           Ref         0.697 (0.570-904)         0.007         0.625 (0.489-0.799)         <0.001	Comorbidity	× ,		· · · · ·		
Yes         0.860 (0.698-1.061)         0.159         1.024 (0.845-1.242)         0.806           Surgical resection         I         Kef         K	, No	Ref		Ref		
Arrigical resection         Ref           Lobectomy         Ref         Ref           Bilobectomy         1.013 (0.745-1.376)         0.935         1.089 (0.820-1.447)         0.557           Pneumonectomy         0.840 (0.501-1.408)         0.508         0.871 (0.532-1.426)         0.583           Histology         -	Yes	0.860 (0.698-1.061)	0.159	1.024 (0.845–1.242)	0.806	
Lobectomy         Ref         Ref           Lobectomy         1.013 (0.745-1.376)         0.935         1.089 (0.820-1.447)         0.557           Pneumonectomy         0.840 (0.501-1.408)         0.508         0.871 (0.532-1.426)         0.583           Histology           Ref         0.867         0.697 (0.532-1.426)         0.583           Histology           Ref         0.697 (0.537-0.904)         0.007         0.625 (0.489-0.799)         <0.001	Surgical resection	× ,		· · · · ·		
Bilobectomy         1.013 (0.745-1.376)         0.935         1.089 (0.820-1.447)         0.557           Pneumonectomy         0.840 (0.501-1.408)         0.508         0.871 (0.532-1.426)         0.583           Histology           Kef         Kef         0.697 (0.637-0.904)         0.007         0.625 (0.489-0.799)         <0.001	Lobectomy	Ref		Ref		
Pneumonetomy         0.840 (0.501–1.408)         0.508         0.871 (0.532–1.426)         0.583           Histology         Adenocarcinoma         Ref         Ref         0.593           Squamous cell carcinoma         0.697 (0.537–0.904)         0.007         0.625 (0.489–0.799)         <0.001	Bilobectomy	1.013 (0.745–1.376)	0.935	1.089 (0.820–1.447)	0.557	
Histology       Ref       Ref         Adenocarcinoma       Ref       Ref         Squamous cell carcinoma       0.697 (0.537-0.904)       0.007       0.625 (0.489-0.799)       <0.001	Pneumonectomy	0.840 (0.501–1.408)	0.508	0.871 (0.532–1.426)	0.583	
Adenocarcinoma         Ref           Adenocarcinoma         0.697 (0.537-0.904)         0.007         0.625 (0.489-0.799)         <0.001	Histology					
Squamous cell carcinoma         0.697 (0.537-0.904)         0.007         0.625 (0.489-0.799)         <0.001           Others         0.893 (0.621-1.285)         0.542         0.921 (0.661-1.283)         0.626           Cell differentiation          Kef         Kef         Kef           Moderate         1.329 (0.761-2.323)         0.318         1.517 (0.903-2.549)         0.115           Poor         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.495 (0.71-1.3.016)         0.261         1.473 (0.774-2.802)         0.238           Adjuvant therapy         Kef         Kef         Kef         Kef           Yes         0.851 (0.677-1.071)         0.170         0.876 (0.779-1.186)         0.712           Pathological T category         T1         Kef         Kef         Kef           T2         1.397 (1.070-1.825)         0.014         1.352 (1.064-1.717)         0.014           T3         1.997 (1.441-2.767)         <0.001	Adenocarcinoma	Ref		Ref		
Others         0.893 (0.621–1.285)         0.542         0.921 (0.661–1.283)         0.626           Cell differentiation         Kef         Kef           Well         Ref         Ref           Moderate         1.329 (0.761–2.323)         0.318         1.517 (0.903–2.549)         0.115           Poor         1.957 (1.128–3.393)         0.017         1.831 (1.094–3.066)         0.021           NA         1.495 (0.741–3.016)         0.261         1.473 (0.774–2.802)         0.238           Adjuvant therapy         Kef         Ref         Ref         0.911 (0.761–1.283)         0.017         0.961 (0.774–2.802)         0.238           Adjuvant therapy         Kef         Ref         Ref         0.712         0.712           Pathological T category         Kef         Ref         0.712         0.712         0.712         0.712           Pathological T category         T1         Ref         Ref         0.014         1.352 (1.064–1.717)         0.014           T3         1.997 (1.471–2.767)         <0.001         1.835 (1.358–2.480)         <0.001           T4         0.927 (1.292–2.873)         0.001         1.835 (1.358–2.480)         <0.001           N0         Ref         Ref         Ref	Squamous cell carcinoma	0.697 (0.537-0.904)	0.007	0.625 (0.489-0.799)	< 0.001	
Cell differentiation         Kef           Well         Ref         Ref           Moderate         1.329 (0.761-2.323)         0.318         1.517 (0.903-2.549)         0.115           Poor         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.495 (0.741-3.016)         0.261         1.473 (0.774-2.802)         0.238           Adjuvant therapy          Kef         Kef         0.551 (0.677-1.071)         0.170         0.961 (0.779-1.186)         0.712           Pathological T category         T1         Ref         Ref         0.712         0.714           T2         1.397 (1.070-1.825)         0.014         1.352 (1.064-1.717)         0.014           T3         1.997 (1.41-2.767)         <0.001	Others	0.893 (0.621–1.285)	0.542	0.921 (0.661–1.283)	0.626	
Well         Ref         Ref           Moderate         1.329 (0.761-2.323)         0.318         1.517 (0.903-2.549)         0.115           Poor         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.957 (1.128-3.393)         0.017         1.831 (1.074-2.802)         0.238           Adjuvant therapy         Image: State Stat	Cell differentiation					
Moderate         1.329 (0.761-2.323)         0.318         1.517 (0.903-2.549)         0.115           Poor         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.495 (0.711-3.016)         0.261         1.473 (0.774-2.802)         0.238           Adjuvant therapy           Ref             No         Ref         Ref <t< td=""><td>Well</td><td>Ref</td><td></td><td>Ref</td><td></td></t<>	Well	Ref		Ref		
Poor         1.957 (1.128-3.393)         0.017         1.831 (1.094-3.066)         0.021           NA         1.495 (0.741-3.016)         0.261         1.473 (0.774-2.802)         0.238           Adjuvant therapy           Kef          0.017         1.831 (1.094-3.066)         0.021           NA         1.495 (0.741-3.016)         0.261         1.473 (0.774-2.802)         0.238           Adjuvant therapy          Kef         Kef         0.017         0.961 (0.779-1.86)         0.712           No         Ref         Ref          0.961 (0.779-1.186)         0.712           Pathological T category            8         6         0.014         1.352 (1.064-1.717)         0.014           T3         1.997 (1.41-2.767)         <0.001	Moderate	1.329 (0.761-2.323)	0.318	1.517 (0.903-2.549)	0.115	
NA         1.49 (0.741–3.016)         0.261         1.473 (0.774–2.802)         0.238           Adjuvant therapy         No         Ref         Ref         Ne         Ref         Ne         Ref         No         0.551 (0.677–1.071)         0.170         0.961 (0.779–1.186)         0.712           Pathological T category         T1         Ref         Ref         72         1.397 (1.070–1.825)         0.014         1.352 (1.064–1.717)         0.014           T3         1.997 (1.441–2.767)         <0.001	Poor	1.957 (1.128–3.393)	0.017	1.831 (1.094–3.066)	0.021	
Adjuvant therapy         No         Ref         Ref           Yes         0.851 (0.677–1.071)         0.170         0.961 (0.779–1.186)         0.712           Pathological T category         T1         Ref         Ref         72         1.397 (1.070–1.825)         0.014         1.352 (1.064–1.717)         0.014           T3         1.997 (1.41–2.767)         <0.001	NA	1.495 (0.741–3.016)	0.261	1.473 (0.774–2.802)	0.238	
No         Ref         Ref           Yes         0.851 (0.677-1.071)         0.170         0.961 (0.779-1.186)         0.712           Pathological T category         T         Ref         Ref         0.712           T1         Ref         Ref         0.712         0.712           T2         1.397 (1.070-1.825)         0.014         1.352 (1.064-1.717)         0.014           T3         1.997 (1.441-2.767)         <0.001	Adjuvant therapy	× ,		· · · · ·		
Yes         0.851 (0.677-1.071)         0.170         0.961 (0.779-1.186)         0.712           Pathological T category         T1         Ref         Ref         1           T2         1.397 (1.070-1.825)         0.014         1.352 (1.064-1.717)         0.014           T3         1.997 (1.441-2.767)         <0.001	No	Ref		Ref		
Pathological T category       Ref         T1       Ref       Ref         T2       1.397 (1.070–1.825)       0.014       1.352 (1.064–1.717)       0.014         T3       1.997 (1.441–2.767)       <0.001	Yes	0.851 (0.677-1.071)	0.170	0.961 (0.779–1.186)	0.712	
T1       Ref       Ref         T2       1.397 (1.070–1.825)       0.014       1.352 (1.064–1.717)       0.014         T3       1.997 (1.441–2.767)       <0.001	Pathological T category	× ,		· · · · ·		
T2       1.397 (1.070–1.825)       0.014       1.352 (1.064–1.717)       0.014         T3       1.997 (1.441–2.767)       <0.001	T1	Ref		Ref		
T3       1.997 (1.441–2.767)       <0.001	T2	1.397 (1.070–1.825)	0.014	1.352 (1.064–1.717)	0.014	
T4       1.927 (1.292–2.873)       0.001       1.806 (1.249–2.611)       0.002         Pathological N category       N0       Ref       Ref         N0       Ref       0.198       1.551 (1.133–2.124)       0.006         N2       2.474 (1.932–3.168)       <0.001	Т3	1.997 (1.441–2.767)	<0.001	1.835 (1.358–2.480)	< 0.001	
Pathological N category       N0       Ref       Ref         N1       1.268 (0.883–1.820)       0.198       1.551 (1.133–2.124)       0.006         N2       2.474 (1.932–3.168)       <0.001	T4	1.927 (1.292–2.873)	0.001	1.806 (1.249–2.611)	0.002	
N0         Ref         Ref           N1         1.268 (0.883-1.820)         0.198         1.551 (1.133-2.124)         0.006           N2         2.474 (1.932-3.168)         <0.001	Pathological N category					
N1       1.268 (0.883-1.820)       0.198       1.551 (1.133-2.124)       0.006         N2       2.474 (1.932-3.168)       <0.001	N0	Ref		Ref		
N2     2.474 (1.932-3.168)     <0.001     2.430 (1.933-3.054)     <0.001       Postoperative complications     No     Ref     Ref       Yes     1.202 (0.827-1.747)     0.335     1.112 (0.779-1.585)     0.559	N1	1.268 (0.883-1.820)	0.198	1.551 (1.133–2.124)	0.006	
Postoperative complications         Ref         Ref           Yes         1.202 (0.827–1.747)         0.335         1.112 (0.779–1.585)         0.559	N2	2.474 (1.932–3.168)	<0.001	2.430 (1.933–3.054)	< 0.001	
No         Ref         Ref           Yes         1.202 (0.827-1.747)         0.335         1.112 (0.779-1.585)         0.559	Postoperative complications			· · · · · · · · · · · · · · · · · · ·		
Yes 1.202 (0.827–1.747) 0.335 1.112 (0.779–1.585) 0.559	No	Ref		Ref		
	Yes	1.202 (0.827-1.747)	0.335	1.112 (0.779–1.585)	0.559	

(Continues)

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#### TABLE 4 (Continued)

	OS		DFS	
Characteristics	HR (95% CI)	P	HR (95% CI)	p
No. of resected N1 LNs	1.005 (0.982-1.028)	0.670	1.007 (0.986-1.028)	0.541
No. of resected N2 LNs	0.989 (0.976–1.002)	0.099	0.988 (0.976-1.000)	0.052
3A dissection				
3A LND <sup>-</sup>	Ref		Ref	
3A LND <sup>+</sup>	1.100 (0.896–1.352)	0.361	1.076 (0.892–1.297)	0.447

Abbreviations: OS, overall survival; DFS, disease-free survival; HR, hazard ratio; CI, confidence interval; Ref, reference; RUL, right upper lobe; RML, right middle lobe; RLL, right lower lobe; NA, not available; LND, lymph node dissection.

Figure 2a) and DFS rates (3A LND<sup>-</sup> group vs. 3A LND<sup>+</sup> group 57.4% vs. 56.0% p = 0.437; Figure 2b) were comparable between the 3A LND<sup>+</sup> group and the 3A LND<sup>-</sup> group. Multivariate analyses also confirmed that 3A LND had no impact on OS (HR = 1.093, 95% CI, 0.890–1.341, p = 0.397; Table 4) or DFS (HR = 1.071, 95% CI, 0.888–1.291, p = 0.473; Table 4).

To identify which group of patients might benefit from station 3A LND after PSM, subgroup analyses based on age, tumor location, anatomical type, smoking history, histology, cell differentiation, pathological T category, and pathological N category were further performed. Unfortunately, the subgroup analyses suggested that station 3A LND had no impact on either OS or DFS in any subset of the matched cohort (all p > 0.05; Supporting Information Table S3, online only).

#### DISCUSSION

Although anatomical lobectomy combined with MLND has been widely accepted as the standard surgical treatment for early-stage NSCLC, there is no uniform standard of the extent of MLND.<sup>3-5</sup> Therefore, the decision to dissect specific mediastinal lymph nodes in clinical practice is mainly dependent on individual surgeons' experience and preference.<sup>18</sup> In our previous studies, we demonstrated that station 3A LNM occurred in 11.7% (76/648) of right-side NSCLC patients who underwent complete resection,<sup>14</sup> and even in patients whose tumors were no more than 3 cm, 9.6% of patients still had station 3A LNM.<sup>15</sup> Nevertheless, previous studies, including ours, suggested that in clinical practice, only approximately 30% of patients underwent station 3A LND during surgery.<sup>14,16,23</sup> To the best of our knowledge, only one study retrospectively investigated the prognostic significance of station 3A LND using data from a single institution.<sup>23</sup> It is therefore important to clarify the clinical significance of station 3A LND in right-side NSCLC patients who underwent surgical resection.

In this study, our data suggested that station 3A LNM occurred in 11.3% of right-side NSCLC patients who underwent complete resection, which is similar to the findings of previous studies.<sup>14,15,23</sup> The data also showed that in patients with station 3A LNM, 77.2% had multistation MLNM while only 22.8% did not have MLNM of other stations. These findings suggested that the occurrence of station 3A LNM corresponded to widespread disease. Interestingly, the data suggested that station 3A LND had no impact on either OS or DFS in the matched cohorts, and this result was also confirmed by the multivariate analyses and subgroup analyses. One possible explanation for this result is that 3A LNM suggests a widespread disease that requires multimodality therapy, and the role of surgical resection as a local treatment in these patients was compromised. Moreover, our data showed that patients with 3A LND had significantly more drainage on postoperative day 1 than those without 3A LND and after PSM patients with 3A LND still had an average of 31.6 ml more drainage than those without. Based on these findings, we suggest that the dissection of station 3A lymph nodes itself is not associated with long-term outcomes and it is unnecessary to dissect station 3A lymph nodes during the surgery for right-side NSCLC.

The MLNM pattern of right-side NSCLC has also been assessed by previous studies.<sup>16,23,24</sup> Riquet et al. performed a retrospective study that included 1779 NSCLC patients who underwent lobectomy combined with MLND.16 Their results showed that 15.4% (159/1035) of patients with rightside NSCLC had N2 diseases and 120 patients (11.6%, 120/1035) had single-station LNM. Among the cases of single-station involvement, only two patients (1.7%) were diagnosed with station 3A LNM. In contrast, 80 (66.7%) patients with single-station involvement had station 2R/4R LNM and 36 (30.0%) patients had single-station 7 LNM, which was similar to our results. Liu et al. performed retrospective research using PSM analysis to investigate the impact of station 3A LND on long-term survival in patients with right-side NSCLC.<sup>23</sup> They found that the metastasis rate of station 3A lymph nodes was 15.3% (87/570), and this value was second only to that of station 4 LNM (17.3%, 287/1660). Our data in this study also demonstrated that station 3A LNM was not rare (11.3%) but it was more likely to detect multistation MLNM when station 3A LNM occurred, indicating the limited value of station 3A LND for improving long-term survival.

To the best of our knowledge, only one previous study has DISCLOSURE focused on the impact of station 3A LND on long-term out-ORCID REFERENCES

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comes.<sup>23</sup> Liu and his colleagues demonstrated that patients with station 3A LND showed higher DFS (5-year DFS, 52.4% vs. 37.1%, p = 0.001) and OS (5-year OS, 58.8% vs. 48.7%, p = 0.007) than those without station 3A LND.<sup>23</sup> The results of their study were not consistent with ours. It is worth noting that the PSM analysis in Liu et al.'s study did not include the number of resected lymph nodes in the propensity score model. While it had already been confirmed that the number of resected lymph nodes was intensely associated with longterm outcomes,<sup>25,26</sup> excluding the number of resected lymph nodes as a variable in PSM may cause bias when comparing the survival prognosis in their study. In our series, the data showed that the number of resected lymph nodes in the station 3A LND<sup>+</sup> group was significantly larger than that in the station 3A LND<sup>-</sup> group (p < 0.001). We therefore believe that including the number of resected lymph nodes in the propensity score model to balance this variable between groups is very important. In addition, as Liu et al. admitted in their article, the follow-up period of their research was relatively short (median follow-up of 33 months), and further follow-up was essential to draw a reliable conclusion. In this study, the median follow-up period was as long as 55 months, which was much longer than that in their study. We believe that the long follow-up period and inclusion of the number of resected nodes as a variable in the PSM model improved the reliability of the results of this study, and it may also explain the discrepancies between Liu et al.'s study and ours.

Our study also has its limitations. First, this is a singlecenter retrospective study and bias may also exist due to the retrospective nature. For example, patients with station 3A LND were more likely to have more lymph nodes resected, but we could not know the exact reason for this. One possible explanation might be that the surgeons who preferred to dissect station 3A lymph nodes during surgery were more likely to perform extensive systematic MLND. Second, although the PSM method was used to minimize selection bias, this method could only control confounding factors that were already identified, but other unknown factors may impact survival. In short, well-designed prospective clinical trials are warranted to testify our results.

In conclusion, our results indicated that patients with station 3A LNM were more likely to have multistation MLNM and station 3A LND could not improve long-term outcomes. We therefore propose that station 3A LND was unnecessary in the surgical treatment of right-side NSCLC.

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#### SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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