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ORIGINAL ARTICLE

Combination of interventional pulmonology techniques (Nd:YAG laser resection and brachytherapy) with external beam radiotherapy in the treatment of lung cancer patients with Karnofsky Index ≤ 50

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Summary

Purpose: *To compare Nd:YAG laser resection with Nd:YAG laser plus brachytherapy and external beam radiotherapy (EBRT) in the palliation of malignant central airway obstruction symptoms due to lung cancer.*

Patients and methods: *In this prospective non-randomized study we evaluated the effects of Nd:YAG laser photoresection alone vs. Nd:YAG laser resection in combination with brachytherapy and EBRT on cough, dyspnoea, thoracic pain, haemoptysis, body weight loss, atelectasis, postobstructive pneumonia, endoscopic findings, disease-free period and survival rate in lung cancer patients. Only patients with Karnofsky index (KI) ≤50 were included. Sixty-four patients were divided into 2 groups: group I patients (n = 20) were treated only with Nd:YAG laser, and group II patients (n = 44) were treated with Nd:YAG laser followed by brachytherapy and EBRT.*

Results: *Group I patients showed statistically significant improvement in all investigated parameters but cough. Group II patients achieved significant improvement in all investigated parameters. Comparative statistical analysis between the 2 groups revealed statistically significant improvement in group II with regard to dyspnoea, haemoptysis, KI and atelectasis. No significant improvement in group II was seen when other investigated parameters were considered. Disease-free period and survival rate were significantly longer in group II (p ≤0.0005).*

Conclusion: *The combination of interventional pulmonology procedures with standard modalities is the best option for the treatment of selected lung cancer patients.*

Key words: brachytherapy, lung cancer, Nd:YAG laser resection, palliation, quality of life

Introduction

The palliative effect of interventional pulmonology procedures in the treatment of lung cancer patients is well known and recognized. In recent years many studies have revealed possible curative effect of these procedures, especially in the treatment of early-stage lung cancer, carcinoma *in situ* and some histological cancer types (e.g. typical carcinoid, mucoepidermoid carcinoma or fibrosarcoma) situated intraluminally [1,2]. The increase in number and variety of interventional pulmonology methods led to the development of internationally accepted guidelines for their potential use [3,4]. As it stands today, interventional pulmonology procedures are divided into techniques with immediate effect (laser resection, tracheobronchial stents, argon plasma coagulation, electrocautery), techniques with delayed effects (pho-

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todynamic therapy, cryotherapy, brachytherapy) and interventional techniques with diagnostic intent, such as autofluorescent bronchoscopy (AF), endobronchial ultrasound (EBUS) or some novel approaches like combination of EBUS with transbronchial needle aspiration and electromagnetic navigation. The use of these methods does have serious impact on the diagnosis, treatment, quality of life (QoL) and outcome in lung cancer treatment.

Lung cancer is unfortunately diagnosed in advanced stage in most cases. This is one of the major reasons why curative surgical treatment is possible in only about 20% of the patients. End-stage tumor recurrences, causing central airway obstruction after failure of previous chemoradiotherapy regimens, refer patients to interventional pulmonology departments. The QoL of lung cancer patients is seriously jeopardized by local, regional or metastatic spread of the disease. One of the major concerns is significant airway obstruction caused by intraluminal tumor growth, extraluminal compression or combination of both. Urgent airway debulking, using interventional pulmonology techniques in order to prevent suffocation, is a life-saving procedure in these cases. One of the accepted strategies of the treatment is combination of interventional techniques; tumor coagulation followed by debulking, and, if necessary, placement of tracheobronchial stents. Patients with KI <50 are often not candidates for standard chemoradiotherapy regimens. The QoL or life itself of these patients are seriously jeopardized by central airway obstruction, the danger of suffocation or massive hemorrhage. In cases of imminent respiratory failure manifested with symptoms like stridor and severe dyspnoea it is absolutely necessary to apply interventional pulmonary techniques for immediate disobstruction. Other interventional procedures, such as brachytherapy, can follow in order to achieve the best possible palliation. After the improvement in performance status and respiratory function of the patient, administration of standard chemoradiotherapy regimens can be evaluated. A large number of studies evaluating the effects of interventional pulmonary procedures confirms that the best results are achieved with the combination of standard chemoradiotherapy regimens with endobronchial therapy, whenever possible.

Nd:YAG photoresection (Figures 1 and 2) of lung cancer invading central airways has proved to be safe and efficient method in the treatment of lung cancer patients. Usually, laser resection is used for palliation. It can be applied alone, in urgent debulking of central airways, or it can be followed by other interventional pulmonary procedures, such as brachytherapy, stent placement, argon plasma coagulation or electrocautery, in order to achieve the best possible palliation [5]. Laser resection is a method which can be deployed via flexible or rigid bronchoscope, or the combination of them. Malignant lesions most suitable for laser resection are centrally located, intrinsic, and small (< 4 cm) with a visible distal endobronchial lumen. The wavelength of the Nd:YAG laser is 1.064 nm in the infrared region, and the beam can be delivered via flexible bronchoscope, navigated with a pilot light. The laser is usually applied at a power of about 40 W,

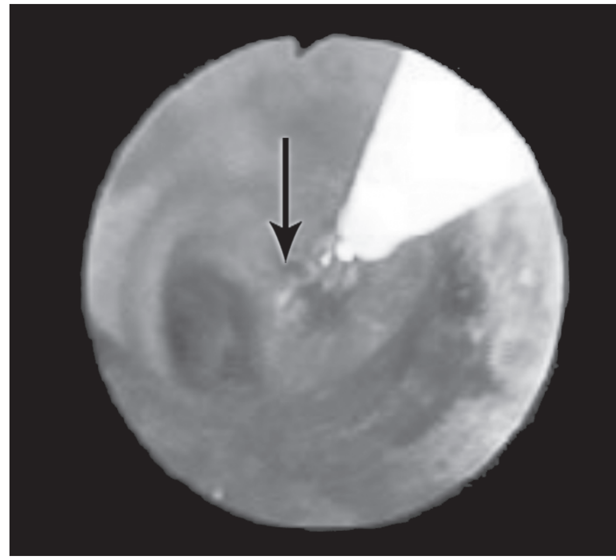

Figure 1. Nd:YAG laser resection of squamous cell carcinoma in bronchus intermedius; arrow points the direction of the laser beam.

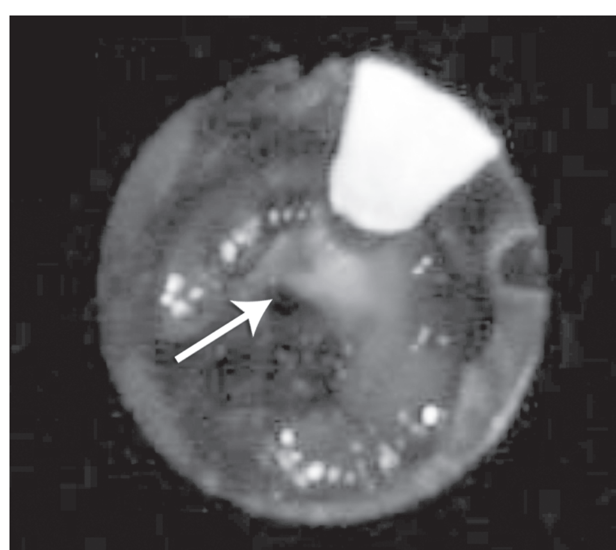

Figure 2. Nd:YAG laser resection of adenocarcinoma in the right main bronchus (arrow).

with pulls duration of 0.1-0.2 sec, aimed parallel to the airway at a distance of 4-10 mm from the lesion. The power can be set according to the type of target tissue (e.g. vascularized tumors, fibrous tissue). The penetration depth into tissue is usually 5-10 mm, and depends on the power setting applied and the duration of pulls [1,5]. Absolute contraindication for laser therapy is extraluminal disease; potential relative contraindications include cardiovascular risks, increased respiratory demands, unresolved coagulopathies, and haemodynamic instability. However, in cases when prompt debulking is necessary, some of these potential contraindications, such as increased respiratory demands, can be dismissed. Overall reported complications in the form of bleeding, airway perforation, fistulae forming, airway fire or serious hypoxemia do not exceed 5%; in most published studies the complication rate is lower than 5% [5].

Brachytherapy (Figures 3 and 4) is a form of radiation treatment in which encapsulated radioactive sources are placed within or near the tumor. It has been used for treating many types of lung cancer. Fewer than 25% of the patients with lung cancer have resectable disease at the time of diagnosis and 75% have non-small cell lung cancer (NSCLC), often centrally located in the airways, causing atelectasis, postobstructive pneumonia, and haemoptysis which responds poorly to chemotherapy. Therefore, radiation therapy is an important modality for their treatment. EBRT is considered standard therapy for such patients. It is effective in reversing atelectasis in only about 21% of the patients. Tumor recurrence after EBRT is up to 50%, and additional irradiation is rarely possible. Those facts have made place for the use of brachytherapy in the treatment of lung cancer. Brachytherapy is typically performed with the radiation source remaining within the airway. The most common source of radiation is iridium-192 (^{192}Ir), which is delivered endobronchially via catheter using afterloading technique. In this technique a blind tipped catheter is placed at the desired position (usually under fluoroscopic control), and the radiation source is then loaded afterward. One of the benefits of this method is avoiding radiation exposure of the endoscopy personnel. There are 3 methods for the application of brachytherapy: low-dose rate (LDR), intermediate-dose rate (IDR) and high-dose rate (HDR). Most often method used is HDR. HDR delivers more than 1000-1200 cGy/h and each fraction lasts between 3-30 min. Typical regimens deliver 500 cGy at 10 mm, with an average of 3 fractions weekly and a total dose of 1500 cGy [1,6,7]. This regimen is suitable for outpatient application. The main advantage of brachytherapy is that the catheter can be placed in segmental bronchi, usually beyond reach of other interventional procedures. One of the disadvantages of brachytherapy is its delayed action, so it can not be used for prompt airways debulking. Some recent publications are suggesting beneficial use of brachytherapy in the curative treatment of early-stage lung cancer and benign cicatricial tracheobronchial stenoses [1,8].

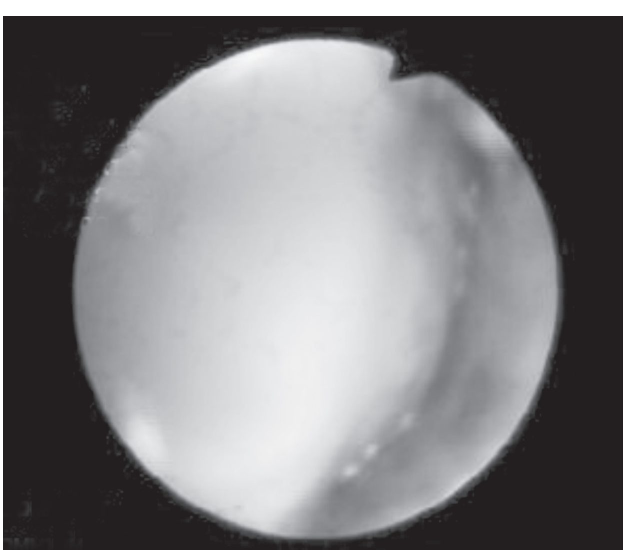

Figure 3. Extraluminal compression; indication for brachytherapy and/or stent.

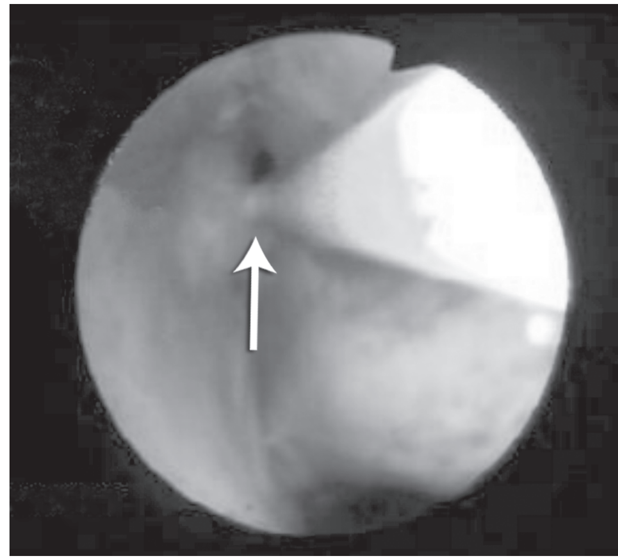

Figure 4. Brachytherapy; placement of blind tipped catheter at the site of extraluminal compression (arrow).

In recent years palliative treatment of lung cancer in order to achieve the best symptom control is on the one hand a combination of standard treatments in the

Table 1. Speiser's obstructive score [12]

Localization	*Level of obstruction*	*Score*
	More than 50%	10
Trachea	Less than 50%	6
	Less than 10%	2
	More than 50%	6
Main bronchi	Less than 50%	3
	Less than 10%	1
Lobar bronchi	More than 50%	2
	Less than 50%	1
Atelectasis		2 per lobe
Pneumonia		2 per lobe

form of chemotherapy (where applicable) and EBRT, and on the other hand the use of various interventional pulmonology procedures in order to achieve better QoL and survival of patients. Which interventional pulmonary procedure will be used for treatment depends on the availability of the procedures and expertise of the personnel [9,10]. Interventional pulmonology techniques are quite expensive and they should be performed in tertiary medical institutions, in which the trained personnel and adequate equipment are easily accessible [3,11]. Interventional pulmonology uses multidisciplinary approach to the central airway obstruction, e.g. team of interventional pulmonologists, thoracic surgeons, anesthesiologists, oncologists and radiologists who should be available at any moment to provide the best possible care for the patients.

The aim of this study was to determine which treatment (laser resection alone or laser resection followed by brachytherapy and EBRT) offers better palliation in selected lung cancer patients.

Patients and methods

This study was prospective, non-randomized and was performed at the Institute for Pulmonary Diseases of Vojvodina and partially at the Institute for Oncology of Vojvodina, Sremska Kamenica, Serbia, having been approved by the ethical committee of both Institutes.

Patients included in the study had unresectable lung cancer with endoscopically visible tumor in the trachea or main bronchi, and Speiser's obstruction score more than 8 (Table 1) [12]. Included were patients with KI ≤ 50, while those older than 70 years were excluded from the study. We evaluated 64 patients who were divided into 2 groups. Group I consisted of 20 patients who received only laser resection (due to technical problems in the radiation department). Group II consisted of 44 patients who received laser resection, followed by brachytherapy and EBRT. In group I there were 18 (90%) males and 2 (10%) females; in group II 37 (84%) males and 7 (16%) females. The average age in group I was 57 years, and in group II 58 years. All patients had histologically proven lung cancer (Table 2).

Included patients had TNM stage IIIB and IV. In group I there were 15 (75%) patients with stage IIIB and 5 (25%) with stage IV. In group II there were 40 (90.91%) patients with stage IIIB, and 4 (9.09%) with stage IV.

The following lung cancer symptoms and signs were monitored during the study: cough, haemoptysis, dyspnoea, thoracic pain, body mass changes. For evaluation of brachytherapy and laser resection effects on these symptoms we used the Speiser's protocol (Table 1) [12]. Performance status was evaluated according to KI. Radiographic improvement in atelectasis was evaluated on the basis of standard chest x- ray as well as on CT scan of the thorax; postobstructive pneumonia was evaluated on standard chest x-ray and on clinical presentation and fever, according to the mentioned Speiser's protocol [12].

Lung function tests were monitored before and after interventions: FVC (forced vital capacity), FEV1 (forced expiratory volume in the first second), Raw (resistance), Sraw (resistance in small airways), VC (vital capacity), Tiffeneau index, PO_2, PCO_2 and SO_2.

Laser resection was performed at the respiratory endoscopy unit of the Institute for Pulmonary Diseases of Vojvodina, Sremska Kamenica, using Sharplan

Table 2. Frequency of lung cancer histologies in both groups of patients

	Squamous cell carcinoma n (%)	*Adenocarcinoma n (%)*	*Small-cell carcinoma n (%)*	*Large-cell carcinoma n (%)*	*Other n (%)*	*Total n (%)*
Group I	13 (65)	3 (15)	3 (15)	0 (0)	1 (5)	20 (100)
Group II	30 (68.18)	6 (13.64)	6 (13.64)	1 (2.27)	1 (2.27)	44 (100)
Total	43 (67.19)	9 (14.06)	9 (14.06)	1 (1.56)	1 (1.56)	64 (100)

3000 Nd:YAG laser. The procedure was conducted under general anesthesia, using flexible bronchoscope via modification of Friedel's rigid bronchoscope. The modified Friedel's rigid bronchoscope had a specially constructed tracheal tube, shorter than standard and without lateral perforations, allowing better ventilation and easier resection of tumors located proximally in the trachea. This modification also allowed insertion of the pusher for application of silicone stent and forceps for extraction of necrotic debris.

Endobronchial brachytherapy was conducted after endoscopic evaluation, CT scanning and computer-based planning at the radiology department of the Institute for Oncology of Vojvodina, Sremska Kamenica. After insertion of the catheter, afterloading technique and HDR (Microselectron) method were used, with ^{192}Ir. We delivered 7 Gy per fraction, 1 cm distance from the source, one fraction per week, for 2 weeks. After one week, EBRT followed, using split course, with 40 Gy in 10 fractions (2×5 fractions).

Statistics

Statistical analysis was performed using SPSS for Windows; we used standard statistical methods: x^2 test, Student's t-test, Kaplan-Meier cumulative proportion test, Mantel-Cox test and Gehan's Wilcoxon test.

Results

Cough was present in all investigated patients of both groups. After treatment in group I the decrease in the frequency of cough was 25% (p=0.69) and in group II was 50% (p=0.0005). Comparative analysis between groups showed no statistically significant difference, but considering the results above we can claim that better treatment option for cough palliation is the combination of laser resection, brachytherapy and EBRT (Figure 5).

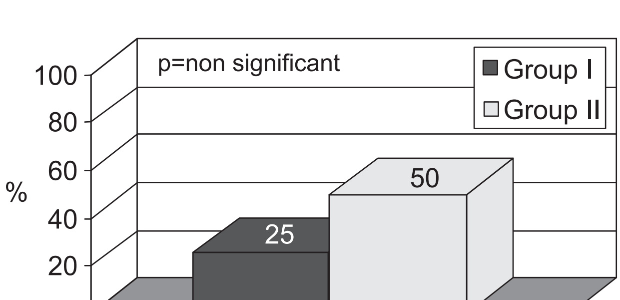

Figure 5. The decrease in frequency of cough after treatment in group I and II.

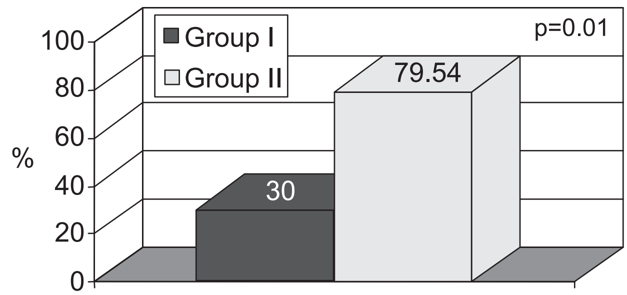

Figure 6. The decrease in intensity of dyspnoea after treatment in group I and II.

Dyspnoea was present in all patients of both groups. After treatment the decrease in intensity of dyspnoea was 30% in group I (p=0.04) and 79.5% in group II ($p < 0.0005$). Comparative analysis between groups revealed statistically significant difference (p=0.01) favoring group II with regard to dyspnoea (Figure 6).

Haemoptysis before treatment was present in 16 (80%) patients in group I, and in 33 (75%) in group II (Figure 7). After treatment the decrease in frequency of haemoptysis was 56.25% in group I (p=0.0062). In group II this decrease was 93.94% ($p \leq 0.0005$). Intergroup analysis showed statistically significant difference (p=0.02), favoring group II treatment (Figure 7).

Pre-therapy thoracic pain was one of the leading symptoms in 15 (75%) group I patients. After treatment the decrease in the frequency of pain was 53.33% (p=0.01). In group II pain was present in 20 (55.45%) patients before treatment. After treatment, the decrease in pain frequency was 70% ($p \leq 0.0005$). There was no intergroup difference, so both treatments were sufficient for pain palliation (Figure 8).

Body weight loss was apparent in 15 (75%) group I and 39 (87%) group II patients. After treatment 94.44% of group I and 97.44% of group II patients stopped loosing weight. In both groups the decrease of stop loosing weight was statistically significant ($p \leq 0.0005$) but there was no intergroup statistical difference (p=0.82).

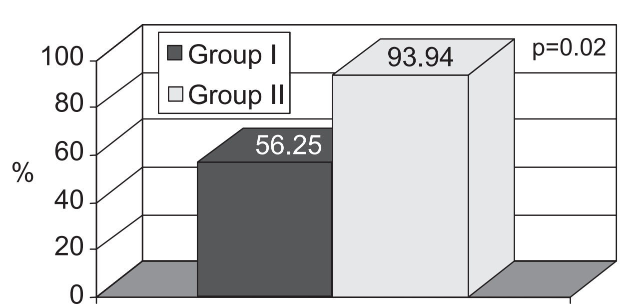

Figure 7. The decrease in frequency of haemoptysis after treatment in group I and II.

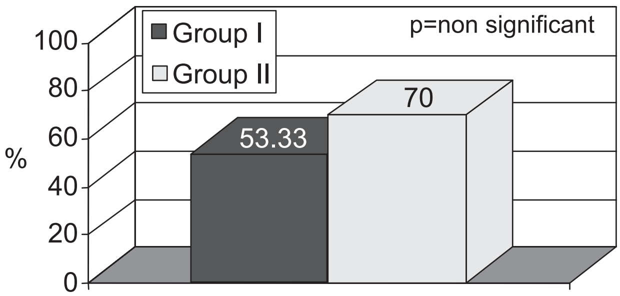

Figure 8. The decrease in frequency of thoracic pain after treatment in group I and II.

The improvement in Karnofsky performance status after treatment is presented in Table 3. Before treatment there were 35% of group I patients with KI 30-40 and 65% with KI 10-20. Post-treatment, there were 25% of patients with KI 90-100, 50% with KI 70-80, 10% with KI 50-60 and only 15% with KI 30-40, without patients with KI 10-20 (Table 3).

In group II, before treatment there were 72.73% of patients with KI 30-40 and 27.27% with KI 10-20. After treatment there were 63.64% patients with KI 90-100, 34.09% with KI 70-80, and only 2.27% with KI 30-40, without KI 10-20 patients. The intergroup difference significantly favored group II ($p < 0.0005$).

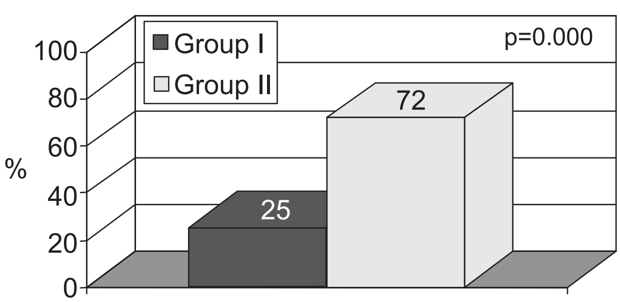

Figure 9. The improvement in atelectasis after treatment in group I and II.

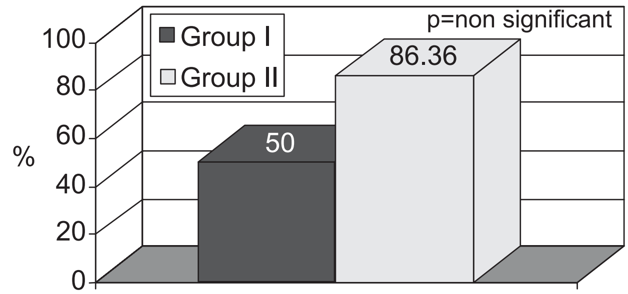

Figure 10. The decrease in frequency of postobstructive pneumonia after treatment in group I and II.

In group I, atelectasis before and after treatment was present in 12 (60%) and 9 (45%) patients, respectively (25% improvement). In group II, the corresponding figures were 25 (56.82%) and 7 (15.91%) patients, respectively (72% improvement) ($p=0.000$; Figure 9).

In group I, clinical and radiographic signs of postobstructive pneumonia were present in 8 (40%) and 4 (20%) patients pre- and post-operative, respectively (decrease by 50%; $p< 0.0005$). In group II, the corresponding figures were 22 (50%) and 3 (6.82%) patients, respectively (decreased by 86.33%; $p < 0.0005$). Intergroup comparison showed no statistical significance ($p=0.24$; Figure 10).

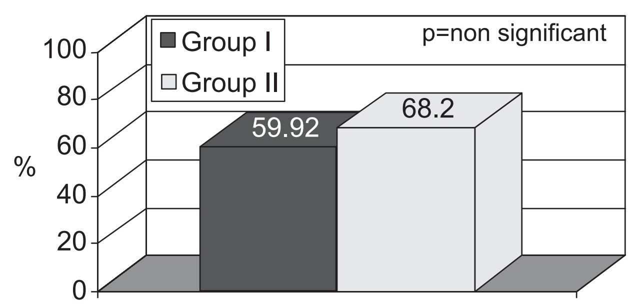

Figure 11. The improvement in obstructive score after treatment in group I and II.

Table 3. Karnofsky index before and after treatment of patients in group I and II

	Group I n=20				*Group II n=44*			
	Before treatment		*After treatment*		*Before treatment*		*After treatment*	
Karnofsky index	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
90-100	0	0.00	5	25.00	0	0.00	28	63.64
70-80	0	0.00	10	50.00	0	0.00	15	34.09
50-60	0	0.00	2	10.00	0	0.00	0	0.00
30-40	7	35.00	3	15.00	32	72.73	1	2.27
10-20	13	65.00	0	0.00	12	27.27	0	0.00

p-value < 0.0005 favoring group II

Table 4. Improvement in lung function parameters in group I after treatment

Lung function parameters	*Before intervention* Average value	SD	*After intervention* Average value	SD	*Decrease %*	*Increase %*	x^2, *p*
FVC	2.14583	0.67303	2.92200	0.62348		36.45	≤0.0005
FEV_1	1.40150	0.55181	1.90600	0.57083		35.71	≤0.0001
Tiff	63.95833	17.34917	70.69000	14.06236		10.54	≤0.0229
Raw	1.03033	0.84025	0.56222	0.55394	45.41		≤0.0074
SRaw	4.31583	3.78035	2.06222	2.65603	52.31		≤0.0343
PO_2	7.21071	1.99492	9.82750	1.16123		36.34	≤0.0090
PCO_2	5.46786	0.88982	5.12833	0.52863	6.22		≤0.0141
SO_2	90.69286	2.54663	94.82500	1.23666		4.55	≤0.0004

FVC: forced vital capacity, FEV_1: forced expiratory volume in first second, Tiff: Tiffeneau index, Raw: resistance, Sraw: resistance in small airways, PO_2: oxygen partial pressure, PCO_2: carbon dioxide partial pressure, SO_2: oxygen saturation, SD: standard deviation

With regard to obstruction (bronchoscopical findings) group I patients had average obstructive score 23.63 and 8.05 before and after treatment, respectively (52.92% improvement; p <0.0005). The corresponding figures for group II patients were 17.56 and 5.58 (68.2% improvement; p <0.0005). However, there was no statistically significant difference between the 2 groups (Figure 11).

After treatment a significant improvement was seen in all investigated lung function parameters in both groups, except PCO_2 in group II (Tables 4, 5).

Kaplan-Meier analysis of disease-free period in group I revealed remission in 15% of patients at 6 months, and 8% at 1, 1.5 and 2 years. In group II, the corresponding figures were 62% at 6 months and 20%, 13% and 9% at 1, 1.5 and 2 years (Figure 12). Mantel-Cox comparative analysis of disease-free period showed significantly better results in group II (p = 0.0003).

Kaplan-Meier analysis of overall survival in group I revealed survival at 6 months, 1 year, 1.5 years and 2 years in 22% of patients each. In group II survival at 6 months 1 year, 1.5 years, 2 years and 2.5 years was 93%, 80%, 44%, 27% and 20%, respectively. Gehan's-Wilcoxon test showed statistically significant better survival in group II (Figure 13).

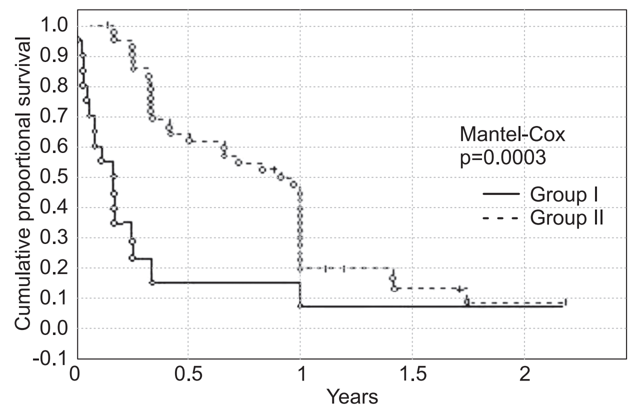

Figure 12. Mantel-Cox comparative analysis of disease-free period after treatment in group I and II.

Table 5. Improvement in lung function parameters in group II after treatment

Lung function parameters	*Before intervention* Average value	SD	*After intervention* Average value	SD	*Decrease %*	*Increase %*	x^2, *p*
FVC	2.35263	0.63803	3.32974	0.67525		41.70	≤0.0005
FEV_1	1.60266	0.49041	2.73211	2.68550		70.62	≤0.0139
Tiff	65.00026	16.88353	72.61389	8.97279		11.71	≤0.0004
Raw	0.70833	0.54992	0.34563	0.23543	51.20		≤0.0002
SRaw	3.43456	3.93228	1.56188	1.55314	54.52		≤0.0032
PO_2	7.88769	1.38932	9.76564	1.05659		23.70	≤0.0005
PCO_2	5.29821	1.31441	5.12538	0.60793	3.21		≤0.3355
SO_2	89.39487	8.15788	94.56410	1.79172		5.77	≤0.0054

For abbreviations see footnote of Table 4

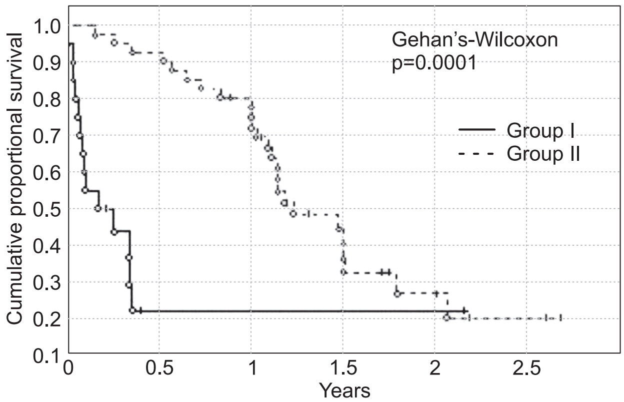

Figure 13. Gehan's-Wilcoxon test comparing overall survival time in group I and II.

Discussion

The role of interventional pulmonology techniques in the curative treatment and palliation of lung cancer patients becomes more important with the passing of time [12,13]. The palliative effect of interventional techniques has been confirmed in many studies [14-19], including our study. Their curative effect is reserved for selected indications and selected patients, however many studies also confirm their effectiveness [20-22]. Techniques for urgent debulking of central airways are life-saving and absolutely necessary in order to prevent death. Techniques with delayed effect improve the QoL of lung cancer patients. Development of new interventional techniques like autofluorescent bronchoscopy and endobronchial ultrasound can change decision-making in the diagnosis and treatment of lung cancer [23-29].

Nd:YAG laser resection of centrally located lung cancer has great palliative potential [30-33]. The largest studies published are by the Cavaliere's group who confirmed that the effect depends on tumor location. Tumors in the trachea, right main and left main bronchus were treated with success rate of 97%, 94% and 86%, respectively, and radiographic improvement was achieved in 93% of cases [34,35]. After laser resection and placement of tracheobronchial stents Venuta et al. [36] found improvement in atelectasis, KI, haemoptysis, dyspnoea, cough and infection. In their study 3-year survival was 52-59%, with improvement in QoL. Better survival after combination of Nd:YAG laser resection and brachytherapy was confirmed by Shea et al. [37] when compared to laser resection alone (16.4 vs. 40.8 weeks). Moghissi et al. [38] combined laser resection and photodynamic therapy; they observed radiographic improvement in 93% of the patients, symptom relief in 100%, with 1-year survival of 65%. In our study group after laser resection alone we observed 25% (non significant) improvement in cough, 30% in dyspnoea, 53.33% in thoracic pain, 56.25% in haemoptysis, 94.44% in body weight loss, 25% in atelectasis, 50% in postobstructive pneumonia, 59.92% in endoscopic findings, improvement in all investigated lung function parameters, and improvement in performance status. Disease-free period in the first group at 6 months, 1, 1.5, 2 years was 15%, 8%, 8%, 8%, respectively, and survival was 22% for each time period, respectively. The palliative role of brachytherapy in the treatment of lung cancer is well known for a longer period of time and many studies have confirmed good effects of brachytherapy on symptom control of lung cancer [38-41]. Recently Escobar-Sacristian et al. published their results after use of high dose rate brachytherapy (HDREB); 85% of symptoms they have analyzed (haemoptysis, cough, dyspnoea, stridor, expectoration) disappeared after treatment and endoscopic response was complete in 56.7% of the patients [7]. In 2000 Muto et al. [42] after HDREB observed 94% improvement in the control of haemoptysis, 90% reduction in dyspnoea and postobstructive pneumonia and 70% improvement in performance status. Kelly et al. in their study identified 78% of patients with bronchoscopic improvement, 66% with symptomatic improvement and 88% of evaluable patients with radiographic improvement [43]. Petera and associates [44] reported 85% of patients with bronchoscopic response, 90% with symptom relief and 60% with radiographic response after HDREB. In 2002 Celebioglu et al. reported significant improvement in dyspnoea, cough, pneumonia and endoscopic findings [45]. In our study group after the Nd:YAG laser resection, brachytherapy and EBRT we found significant improvement in all investigated parameters: cough 50%, dyspnoea 79.54%, thoracic pain 70%, haemoptysis 93.94%, body weight loss 97.44%, atelectasis 72%, postobstructive pneumonia 86.36%, endoscopic response 68.2% and improvement in performance status and lung function tests. Control of dyspnoea, haemoptysis, atelectasis and performance status improvement were better in the second group, suggesting that combined treatment modality is better option for improvement of these symptoms. Disease-free period at 6 months, 1, 1.5, and 2 years was observed in 62%, 20%, 13% and 9% of patients, respectively. Survival at 6 months, 1, 1.5, 2 and 2.5 years was observed in 93%, 80%, 44%, 27% and 20% of patients, respectively.

Conclusions

Even though palliative treatment of lung cancer patients with poor performance status is very limited, interventional pulmonology techniques, although expensive, must not be ruled out as a palliative strategy. There is no doubt that our study confirms the great effectiveness of Nd:YAG laser resection in the palliation of lung cancer symptoms. After laser resection alone, we observed statistically significant improvement in the control of all investigated variables: cough, dyspnoea, thoracic pain, haemoptysis, body weight loss, improvement in performance status, atelectasis, postobstructive pneumonia, endoscopic findings, and lung function tests. The same improvement was observed in the group of patients treated with combination of Nd:YAG laser, brachytherapy and EBRT. But in the second group better control of dyspnoea, haemoptysis, atelectasis and performance status was achieved. However, longer disease-free period and better survival in the group of patients treated with the combined modality suggest that the combination of interventional pulmonology techniques, whenever possible, is the best option for treatment of selected lung cancer patients.

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