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Original Research

Comparison of Success Rates of Pleurodesis with Talc, and Holmium–YAG Laser in the Patients with Malignant Pleural Effusion

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ABSTRACT

Objective: We aimed to investigate the efficacy of Holmium-yttrium aluminum garnet (Ho-YAG) laser using video assisted thoracoscopic surgery (VATS) and compare it with the talcslurry pleurodesis in patients with malignant pleural effusion (MPE).

Methods: A total of 51 patients with MPE were included. Patients were divided into two groups. In the laser group, pleurodesis was attempted using Ho-YAG laser through auniportal VATS in 30 patients; in the talc group, pleurodesis was attempted using talc slurry through a small bore chest tube in 21 patients. The success rate of pleurodesis was evaluated using chest X-ray and/or thorax computed tomography obtained at the second month following pleurodesis and was graded as total success, partial success, or failure.

Results: In the laser group, pleurodesis was a total success in 19 (63%) patients and partial in 7 (23%) patients. The volume of pleural effusion drained postoperatively was significantly different between the success subgroups (total success subgroup vs. failure subgroup, p=0.000; partial success subgroup vs. failure subgroup, p=0.001). In the talc group, pleurodesis was a total success in 11 (52%) patients and partial in 6 (29%) patients. The success rates of pleurodesis between the talc and laser groups showed no significant difference (p=0.725).

Conclusion: The use of Ho-YAG laser through VATS is a safe and effective option for pleurodesis in the management of MPE. However, there is no difference between Ho-YAG laser and talc slurry pleurodesis in terms of procedure success rates.

Keywords: Holmium-YAG lasers, malignant, pleural effusion, pleurodesis, talc

INTRODUCTION

One of the most substantial reasons for exudative pleural effusions is malignancy (1) and lung cancer is the most common cause of malignant pleural effusions (MPEs); however, any cancer can spread to the pleura (2). MPE indicates an advanced disease and a limited life expectancy in most cases (3, 4). Most MPEs are resistant to primary cancer treatment and the recurrence rate is high. Also, MPE causes significant dyspnea and deterioration in the quality of life. Therefore, effective management of MPE to improve the quality of life in these patients is crucial. The most common methods used in the management of MPEs are chemical/mechanical pleurodesis followed by the drainage of the pleural fluid using indwelling catheters (5). To date, as there is no consensus on the optimal method for pleurodesis, the attempt to find the optimal method continues.

It has been suggested that interventions performed under general anesthesia through uniportal video-assisted thoracoscopic surgery (VATS) provide certain advantages, such as the total elimination of pleural adhesions, direct observation of lung expansion, and performance of more effective pleurodesis (6). However, data on the role of video-thoracoscopic laser applications for pleurodesis are limited, and most of these studies have been conducted in patients with pneumothorax (7, 8). The holmiumyttrium aluminum garnet (Ho-YAG) laser has a broad range of potential applications; it was used initially for arthroscopic

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surgery. Today, it is commonly used in many surgical areas, including general surgery, urology, laparoscopy, neurosurgery, lithotripsy, angioplasty, orthopedic surgery, and dental surgery (9). To our knowledge, this is the first study using VATS through Ho-YAG laser applications for pleurodesis in patients with MPE. The aim of this study was to determine the efficacy of Ho-YAG laser through a uniportal VATS and compare it with talc slurry pleurodesis in patients with MPE.

METHODS

Study Design

This was a prospective non-randomized controlled study approved by the local institutional ethics committee of the Gaziantep University (Project No: TF.08.22). The inclusion criteria were as follows: presence of MPE, no contraindications for general anesthesia and/or talc pleurodesis, total expansion of the lung, and improvement of dyspnea following the drainage of the fluid. Patients not willing to participate and those with a life expectancy of less than 1month were excluded.

Patients and Procedures for Pleurodesis

Laser group

A total of 30 patients with MPE between January 2008 and March 2011who provided informed consent were included. Laser pleurodesis was performed using Ho-YAG laser through uniportal VATS. The Ho-YAG laser system (Stone Light®; San Jose, California, USA) used for pleurodesis had a wavelength of 2.1 µm, maximum power of 15 watts, and maximum energy/pulse of 1.5 J maximum (invisible radiation in the mid-infrared portion of the spectrum). The pulse duration was 350 µsec. The output of the Ho-YAG laser was focused into a 550 µm core diameter, low OH quartz fiber optics. The same Ho-YAG laser apparatus was used in all patients. The procedure, lasting about 20-30 minutes on an average, was performed under general anesthesia using doublelumen intubation to allow ventilation of a single lung. Uniportal VATS was performed using a 10 mm thoracoport introduced through a 1-1.5 cm long incision in the sixth or seventh intercostal space on the anterior axillary line, followed by introducing an operative Hopkins telescope (Karl Storz Hopkins®; Tuttlingen, Germany) into the pleural space. After the pleural adhesions were separated, pleural effusion was aspirated, and the expansion capacity of the lung was observed. In patients without a confirmed preoperative diagnosis, MPE was confirmed by the examination of frozen section specimens collected during the operation. The sterile fiber of the Ho-YAG laser was connected to the outside of the thoracoscopic aspirator using sterile drapes, having the tip 3 mm ahead on an average; this combined unit was introduced into the pleural space through the channel of the thoracoscope (Figure 1a) before a pleural abrasion was initiated. The Ho-YAG laser energy was directly guided to the parietal pleura to generate an effective abrasion on the surface. The parietal pleura was abraded with the continuous use of pulses of 15W/1.5 J of energy each (Figure 1b). The number of required laser pulses changed depending on the thickness of the parietal pleura. The laser procedure was continued until the surgeon was satisfied with the level of burning that had occurred at the localization of the parietal pleura. A second port entry was not needed in most cases.

If a sufficient abrasion surface was obtained on the pleura following the placement of the chest tube from the port entry hole, a suction of 15 cm H_2O was maintained to aid there-expansion of the lung. During the postoperative follow-up, the chest tube was removed and drainage was discontinued when daily drainage was below 100 mL. The total delivered energy ranged from 3,375 J to 16,899 J.

Talc group

A total of 21 patients with MPE between April 2011 and February 2013who provided informed consent were included. Under local anesthesia, a smallbore catheter (8-10 French, Pleuracan®; Braun, Melsungen, Germany) was placed through the sixth or seventh intercostal space on the posterior axillary line. The lung re-expansion was confirmed in a chest X-ray following the catheter placement. Talc pleurodesis was performed by applying

Figure 1. a, b. (a) Entry of the Ho-YAG laser fiber using athoracoscopic aspirator as a combined unit into the intrapleural space from within the telescope. (b) Areas of abrasion on the parietal pleura formed by the laser

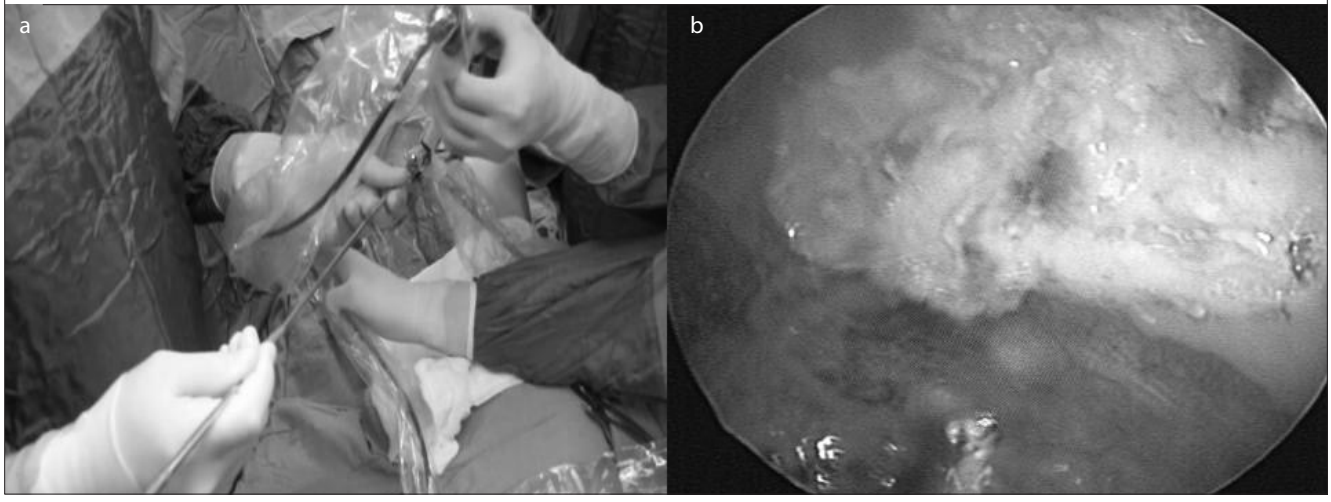


Table 1. Distribution of cases with reference to primary pathology in the laser and talcgroups

Primary pathology	Laser group, N	Talc group, N
Lung carcinoma	7	5
Breast cancer	7	10
Unknown primary etiology	3	2
Other malignancies	13	4

Table 2. Evaluation of pleurodesis success in the laser and talcgroups

Subgroups	Laser group N (%)	Talcgroup N (%)
Total success (0%)	19 (63.3%)	11 (52.4%)
Partial success (<50%)	7 (23.3%)	6 (28.6%)
Failure (>50%)	4 (13.3%)	4 (19%)
Total	30 (100%)	21 (100%)

Table 3. Volume of postoperative drainage based on success subgroups in the laserand talc groups

	Laser group		Talc group	
Subgroups	Mean (mL)	Standard deviation	Mean (mL)	Standard deviation
Total success (0%)	492*	175	255	195
Partial success (<50%)	478†	143	317	232
Failure (>50%)	1337	1012	200	100
Total	601	464	262	197

*: p=0.000 vs. failure subgroup; †:p=0.001 vs. failure subgroup

talc slurry prepared as 4g talc (Steritalc®; Novatech, France) in 100 mL saline through the smallbore catheter. The catheter was clamped for 2 h for keeping talc inside and was subsequently opened. A negative suction was not applied postoperatively to the chest drain. The drained volume of the pleural effusion was monitored daily. When the volume of drained effusion was below 100 mL per day, the catheter was removed and drainage was discontinued.

Outcome Measures

Follow-ups were continued with serial chest X-rays or computed tomography (CT) and quartz fiberoptics of the thorax obtained at the first week, second week, first month, and second month after the surgery. The success rate was defined as total if no re-accumulation of pleural effusion was observed in the postoperative chest X-ray and/or thorax CT at the second month following pleurodesis. The success rate was defined as partial if the volume of pleural effusion in the postoperative chest X-ray and/or thorax CT at the second month following pleurodesis was <50% compared to the preoperative imaging studies. Conditions other than these were evaluated as failures.

Statistical Analyses

For continuous variables, the Student's t-tests was used to compare two implementation groups or the Mann-Whitney U test was used for two-group comparisons; ANOVA or the Kruskal-Wallis test was used for more than three group comparisons. The relationship between categorical variables was determined using the Chi-square test. Descriptive statistics and frequencies were given as mean ± standard deviation (SD). Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS®) for Windows, version 11.5, (SPSS Inc.; Chicago, IL, USA). The statistical analyses were accepted as significant when the p value was <0.05.

RESULTS

Laser Group

Of the 30 patients included, 13 were males and 17 were females, with a mean age of 56.4 years (range, 25-77 years). Dyspnea, cough, and chest pain were the most common complaints at admission. The primary origins of the MPEs are shown in Table 1. The pleural effusions were exudates in all patients. Uniportal VATS was performed on the left side in 18 patients and on the right in 12 patients.

The mean±SD duration of drainage following pleurodesis was 4.4±1.3 days, while the total length of hospital stay was 5.6±1.3 days.

The success rates were as follows: totally successful pleurodesis was observed in 63.3% (n=19) of the patients, partially successful pleurodesis in 23.3% (n=7) of the patients, and failure was observed in 13.3% (n=4) of the patients (p=0.001; Table 2). Two-group comparisons showed that the success rates were significantly different between the total and partial response groups (p=0.004, Figure 2).

Total success rate was achieved in all the breast cancer patients (100%, n=7) and in 85.7% (n=6) of the lung cancer patients.

The mean volumes of pleural effusion drained during the postoperative period were 492.1±175.8, 478.6±143.9, and 1,337.5±1,012.7 mL in the total success subgroup, partial success subgroup, and failed pleurodesis subgroup, respectively, (p=0.001; Table 3).

Pleurodesis was performed with 2.250-11.266 laser pulses. The number of pulses was not statistically different in the subgroups (p=0.717).

There were no differences in gender, chemotherapy, and/or radiotherapy used for the treatment of primary cancer between the subgroups (p=0.568, p=0.893, p=0.104, respectively).

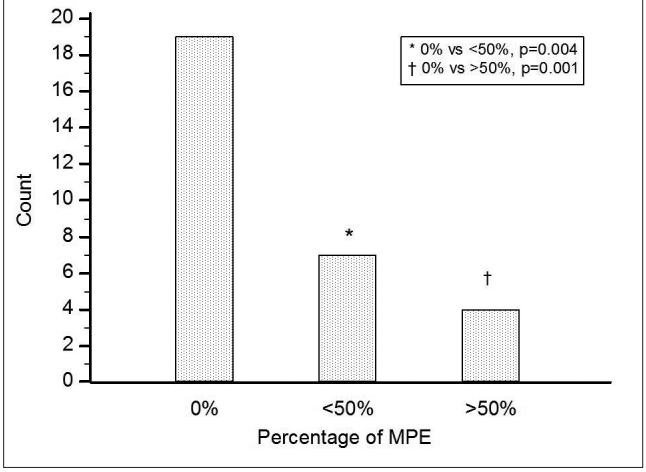
Complications following the procedure were pneumonia in 2 cases, wound site infection in 1 patient, respiratory failure in 1 patient, and arrhythmia in 1 patient. No postoperative mortality was observed.

Table 4. Comparison between laser and talc groups for different parameters

Variable	Talc group (n=21)	Laser group (n=30)	p
Age (years)	54.6±16.6	56.4±13.4	0.669
Initial drainagea (mL)	2785.7±1353.9	3086.6±1415.8	0.451
Mean drainageb (mL)	261.9±201.8	601.6±464.5	0.001
Duration of drainage (days)	4.24±2.42	4.40±1.30	0.759
Duration of hospital stay (days)	4.90±1.99	5.57±1.27	0.156

[a]drainage before pleurodesis procedure; [b]drainage after pleurodesis procedure

Figure 2. Distribution of cases and correlation of the subgroups in the laser group, based on the amount of fluid evaluated radiologically atthesecond postoperative month



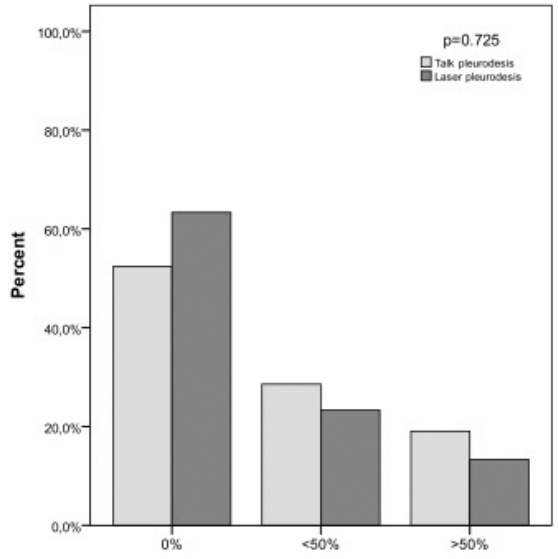
Talc group

Of the 21 patients included, 6 were males and 15 were females, with a mean age of 54.6 years (range, 26-78 years). Dyspnea, cough, and chest pain were the most common complaints. The primary etiology was breast and lung cancer in 48% and 28% of patients, respectively. Pleural fluid was exudates in all cases. Chest tube placement was performed on the left in 7 patients and on the right in 14 patients.

The mean duration before removal of the chest tube was 4.2±2.4 days, while the length of hospital stay was 4.9±2 days.

Eleven patients (52.4%) were accepted to have totally successful pleurodesis without any recurrences. Partial success was achieved in 6 patients (28.6%), while the pleurodesis was failed in 4 patients (19%). The 4 patients who had pleurodesis failure underwent repeated drainage and re-talc pleurodesis. Comparison of the three subgroups showed that the success rates almost achieved the point of statistical significance (p=0.053).

Figure 3. Comparing laser and talc groups according to success subgroups



There was no significant difference in the volumes of the drained pleural fluid, either initially or following the pleurodesis, between the subgroups of different success rates (p=0.259, p=0.639, respectively).

Gender, chemotherapy, and radiotherapy used for the treatment of the primary pathology did not seem to have any influence on the success rates of pleurodesis (p=0.102, p=0.046, p=0.819, respectively).

Complications following the procedure were respiratory failure in 2 patients. No mortality was observed.

Comparison of the Laser and Talc Groups

Both laser and talc groups were found to be normally distributed in terms of age and gender. The two groups showed no difference between the following variables: age, drainage before pleurodesis procedure, duration of drainage, and duration of hospital stay (p=0.669, p=0.451, p=0.759, p=0.156, respectively). However, the difference between the drained volumes of pleural effusion following pleurodesis was statistically significant (p=0.001; Table 4). The success rates of pleurodesis between the talc group and the laser group showed no significant difference (p=0.725; Figure 3).

DISCUSSION

The most common causes of MPE are lung cancer (30%) and breast cancer followed by ovarian and gastric cancer (10, 11). Particularly, for those with primary lung cancer, MPE indicates limited survival of around 6 months. Furthermore, MPE due to lung cancer causes a significant decrease in the quality of life due to dyspnea and respiratory distress (12). The re-accumulation of the effusion occurs rapidly following the drainage in this condition. Therefore, pleurodesis is performed very often in these patients.

The most suitable method of pleurodesis in patients with MPE is not definitely known (13). The frequently used methods worldwide for the management of MPE are talc pleurodesis and placement of indwelling catheters. Talc pleurodesis can be performed either during the uniportal VATS or through a chest tube; these two methods of talc pleurodesis (VATS vs. chest tube) showed conflicting results (13-15). In our experience, the best method of talc pleurodesis should be decided on a casebycase basis. The results of this study showed no difference in the success rates between talc pleurodesis performed through a smallbore chest tube and Ho-YAG laser performed through uniportal VATS. The only difference observed between the two treatment groups was in the total volumes of pleural effusion drained following pleurodesis. In contrast, both methods were found to be more efficient in patients with breast cancer, followed by lung cancers, compared to patients with a primary cancer of other organs.

Videoassisted thoracoscopic surgery (VATS) is safe with low complication rates. VATS has certain advantages, such as the possibility to obtain biopsy under direct visualization, elimination of pleural adhesions, drainage of loculated fluids, direct observation of lung expansion, and the ability to perform pleurodesis during the same procedure (16, 17). We preferred VATS, particularly for releasing loculations and evaluating the maximum expansion of the lungs. In 8 of our patients, the diagnosis of malignancy was obtained during VATS, and pleurodesis was performed during the same session.

Endoscopic applications have been reported since the development of lasers that can be introduced using thin quartz filaments. The application of <30W power in laser provides coagulation, while using around 50W provides vaporization efficacy. In our study, we used the 15W/1.5 J Ho-YAG laser system. The Ho-YAG laser can be easily applied endoscopically through the operative channel of the thoracoscope. If laser energy is to be applied directly to the parietal pleura, a large pleural abrasion and permanent pleurodesis can be obtained. Previous reports have mentioned the use of different types of laser for achieving pleurodesis. However, there were no reports stating the use of Ho-YAG laser for obtaining pleurodesis in MPE cases. In 1993, Bresticker et al. (18) conducted a study on dogs with the aim of studying the efficacy of different pleurodesis methods, and in the evaluation period of 30±2 days, they rated the efficacy of pleurodesis from 0 to 4 (0 corresponds to total absence of pleural adhesions and 4 corresponds to adhesions of the mediastinum inmore than one lobe). They found that the least effective method for pleurodesis was neodymium-doped-YAG laser. They did not recommend using laser techniques for pleurodesis. However, Torre et al. (8) performed pleurodesis on 85 pneumothorax patients using Nd-YAG laser and did not observe any recurrences. In the present study, we had success in 26 patients (86.7%) in the laser group. The pleurodesis was deemed to have failed in 4 patients.

The volume of drained pleural fluid before uniportal VATS and laser pleurodesis was not related to the success rate of pleurodesis (p=0.185); however, there was a statistically significant difference in the volume of postoperatively drained pleural fluid between the subgroups with different success rates (complete success group vs. failure group, p=0.000; partial success vs. failure group, p=0.001). In other words, we suggest that having increased fluid drainage after pleurodesis with Ho-YAG laser predicts the increased risk of failure in pleurodesis. There were no similar differences in the talc group.

Previously, the success rate of talc pleurodesis has been reported to be over 90% in selected patients (19-21). In the present study, the success rate of pleurodesis with talc slurry through a smallbore chest tube was found to be 81% (17 of 21 cases; complete success in 11 patients and partial success in 6 patients). In the laser group, the success rate of pleurodesis was found to be 86.7% (26 of 30 cases; complete success in 19 patients and partial success in 9 patients). The success rates of pleurodesis between the talc and laser groups showed no significant difference (p=0.725). We recommend that laser pleurodesis canbe used as an alternative to talc pleurodesis in selected cases where appropriate equipment and experienced staff are available.

Videoassisted thoracoscopic surgery (VATS) is a safe and well-tolerated method with low operative mortality and complication (22-24). A recent meta-analysis reported no mortality associated with thoracoscopy and that the major complication rate of mini-thoracotomy (MT) was 1.5% and the minor rate was 10.5% (25). The most commonly encountered major complication was acute respiratory failure due to empyema, infection, or re-expansion pulmonary edema in MT (23, 26, 27). In the laser group, 2 of our cases developed pneumonia, 2 had wound site infections, 1 had respiratory failure, and 1 experienced arrhythmia. In the talc group, only 2 patients had respiratory failure. The talc group had fewer complications compared to laser group, Although this difference was not statistically significant (p=0.31).

The drawback of the present study should however be emphasized, considering the limited number of enrolled patients to study and comparing two series of cases in consecutive periods of time.

CONCLUSION

Although the most common methods used worldwide for the management of MPE are talc pleurodesis and placement of indwelling catheters, pleurodesis performed using Ho-YAG laser through a uniportal VATS seems an alternative to talc slurry using a small-bore chest tube. Ho-YAG laser via uniportal VATS can be used safely inappropriately selected patients owing to the low morbidity and mortality. Increased fluid drainage after pleurodesis using Ho-YAG laser could be used as a predictive criterion for pleurodesis failure.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University (No: TF.08.22).

Informed Consent: Written and verbal informed consent was obtained from patients who participated in this study.

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Conflict of Interest: The authors have no conflicts of interest to declare.

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