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Pulmonary Lobectomy. What are the Benefits of Video-assisted Thoracoscopy?

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Abstract

Introduction: Despite the increasing use of video-assisted thoracoscopic lobectomy, this surgical approach is still contr
certain aspects. The purpose of this study is to compare the surgical results of video-assisted thoracoscopic pulmona
to pulmonary lobectomy via thoracotomy.
Materials and Methods: Between 2008 and 2017, 153 patients (n = 89 males) had surgery at the Hospital Universitario F
Favaloro.
Results: 39/89 patients underwent video-assisted thoracoscopic lobectomy. Patients who had video-assisted thoracosc
diagnosed with lung cancer mostly had stage I tumors (25/39 patients). Postoperative complications and mortality rate
in both groups. Video-assisted thoracoscopy patients had a significantly shorter pleural drainage time (4 vs. 3 days, p =
shorter length of hospital stay (6 vs. 4 days of stay, p = 0.03). The number of lymph node stations sampled during surg
in the patients operated via thoracotomy (4 vs. 3.5 lymph node stations, $p < 0.001$).
Conclusion: Video-assisted thoracoscopic lobectomy was at least equivalent to surgery by means of thoracotomy in te
operative complications. The main benefits of the video-assisted thoracoscopy approach were shorter pleural drainage
of hospital stay. Special attention should be paid to nodal sampling when the surgery is performed via video-assisted

Key words: pulmonary lobectomy, video-assisted thoracoscopic lobectomy, postoperative complications

Introduction

The first thoracoscopy was described more than 100 years ago by Jacobaeus in Sweden[1]. However, it was not until the ninety's that the first series of video-assisted thoracoscopic lobectomies was published[2]. After this first series of 45 patients, the interest in performing video-assisted thoracoscopic lobectomies began to grow. The technique was improved and at present there are some reports of major pulmonary resections made by video-assisted thoracoscopy with only one access to the thorax, also called uniportal video-assisted thoracoscopy[3]. Many experts believe that the video-assisted thoracoscopic lobectomy is the technique of choice for the treatment of early-stage lung cancer[4].

Various authors show the advantages of the video-assisted thoracoscopic lobectomy in terms of less pain, less recovery time and fewer postoperative complications[5]. These benefits were shown in several retrospective, comparative studies[6-9]; however, at present, there is not a prospective study validating these conclusions.

Our group has published in 2009 the initial experience with video-assisted thoracoscopic lobectomies[10]. The purpose of this study is to update our series and compare postsurgical results of video-assisted thoracoscopic lobectomies and lobectomies via thoracotomy.

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Materials and Methods

Using our Thoracic Surgery Service prospectively mantained database, we located patients with pulmonary lobectomies between 2008 and 2017. We identified 153 patients who received a pulmonary lobectomy and determined the corresponding registration code of each one of them according to the surgical access. Patients were organized in two groups: lobectomies via thoracotomy and video-assisted thoracoscopic lobectomies. We included all the patients older than 18 years old who received an elective lobectomy, and one patient was excluded with an urgent lobectomy due to hemoptisis. Apart from demographic, surgical and postsurgical data extracted from the records, we reviewed the clinical records of the patients, as well as the surgical and pathology reports.

Surgical technique: the lobectomies via thoracotomy were performed with a posterolateral thoracotomy, with section of the latissimus dorsi muscle and preservation of the serratus. Typically, the posterior arch of the sixth rib was sectioned. The pulmonary resection was carried out in a standard way, sectioning each one of the bronchovascular elements anatomically and dividing the corresponding fissure with a stapler. In cases of lung cancer, we took samples of the 2/4R, 7, 9R, 10R lymph node stations in resections of the right side and the 5/6, 7, 9L, 10L stations in resections of the left side.

Video-assisted thoracoscopic lobectomies were performed with three access ports, one for the optic, another one for traction and an utility incision. The dissection was made through an anterior approach of the pulmonary hilum. In the case of the upper lobes, first we treated the vein, then the artery and at last the bronchus, and then the corresponding fissure was sectioned with a stapler. In the case of mid and lower lobes, we treated the vein, the bronchus and the corresponding artery, in that order, and then the fissure was sectioned with a stapler. The lymph node stations we examined were the same as those in thoracotomies.

Postoperative care: both groups of patients were observed at the Critical Care Unit the first 24 hours after surgery; then, if there were not no complications, the patients would be transferred to the General Care Area. In terms of analgesia, we used endovenous drugs the first 48 hours and then we administered analgesics by mouth. Drains were removed when there were no air leaks and when the output was less than 300 ml in 24 hours. We defined –prolonged air leak– as the presence of a leak for more than five days after surgery.

Statistics: continuous variables were presented as the arithmetic mean (± standard deviation) or median (interquartile range 25-75), whereas the categorical variables were presented as percentages of the patients. Differences between continuous variables were studied with the Student or Mann-Whitney test according to the distribution that was found. The Chi-Square or Fisher tests were used to compare categorical variables. Differences with $p < 0.05$ were considered as statistically significant. We used the SPSS software, version 17.0 to carry out the statistical analyses.

Results

Out of 153 patients who received a lobectomy, 112 were operated by thoracotomy (73%), and 39 via video-assisted thoracoscopy (27%). Table 1 shows the characteristics of all the patients and the differences between both groups. From the results shown in Table 1, we should focus on the following: the demographic characteristics of both groups, in terms of age, gender and breathing functionality were similar; also the different sites of the lobectomies performed in both groups were equivalent.

Patients with stage IA lung cancer were operated by video-assisted thoracoscopy with higher significant frequency (51.3 versus 17.7%; $p < 0.001$). No differences were observed regarding global postoperative complications, with prolonged air leak being the most common complication in both groups (12.4%) followed by atrial fibrillation (9.2%) and respiratory failure (7.2%). Atrial fibrillation was most frequently observed in the group of video-assisted thoracoscopic lobectomy (6.1 versus 17.9%; $p = 0.027$). 30-day mortality was 3.3%, with no significant differences between both groups.

TABLE 1. Demographic Characteristics and Surgical Results Worldwide and in Both Groups

Variable	All the patients (n =153)	Lobectomies via thoracotomy (n = 112)	Video-assisted thoracoscopic lobectomies (n = 39)	p
Demographic data and presurgical ndings				
– Age (years), average ± SD	60.28 ± 12.11	60.15 ± 13.35	60.68 ± 7.35	0.81
– Gender (masculine), n (%)	89 (58.2)	68 (60)	21 (53)	0.52
– Neoadjuvant treatment, n (%)	12 (7.9)	12 (100)	0 (0)	0.34
– Neoadjuvant treatment due to N2, n (%)	10 (6.5)	10 (100)	0 (0)	0.05
– FVC (forced vital capacity), average in liters (%)	3.41 (89)	3.35 (87)	3.61 (95)	0.29
– FEV1 (forced expiratory volume in rst second), average in liters (%)	2.4 (81)	2.46 (81)	2.54 (83)	0.7
– Diffusing capacity for carbon monoxide, percentage	63	63	64	0.92
Preoperative mediastinoscopy, n (%)	22 (14.4)	18 (15.8)	4(10.3)	0.39
– Positive mediastinoscopies, n (%)	6 (3.9)	6 (100)	0 (0)	0.33
Pulmonary lesion sites				
– Right upper lobe, n (%)	62 (40.5)	46 (41)	16 (41)	0.94
– Middle lobe, n (%)	10 (6.5)	6 (4)	4 (10)	0.27
– Right lower lobe, n (%)	27 (17.6)	23 (20)	4 (10)	0.16
– Left upper lobe, n (%)	33 (21.6)	26 (23)	7 (18)	0.52
– Left lower lobe, n (%)	21 (13.7)	13 (12)	8 (21)	0.15
Number of biopsy samples of lymph node stations performed in patients in need of lymph node staging (122), median (25th-75th percentile)	4 (4-5)	4 (4-5)	3.5 (3-4)	< 0.001
Surgical results				
– Postoperative complications, n (%)	47 (30.7)	35 (30.7)	12 (30.8)	0.99
– Prolonged air leak, n (%)	19 (12.4)	15 (13.2)	4 (10.3)	0.63
– Atrial brillation, n (%)	14 (9.2)	7 (6.1)	7 (17.9)	0.027
– Respiratory insuf ciency, n (%)	11 (7.2)	7 (6.1)	4 (10.3)	0.39
– Patients discharged with Heimlich valve, n (%)	11 (7.2)	9 (9.8)	2 (6.1)	0.51
– Deaths, n (%)	5 (3.3)	4 (3.5)	1 (2.6)	0.73
– Duration of surgery (minutes), median (25th-75th percentile)	140 (0-180)	150 (120-180)	160 (135-180)	0.316
– Pleural drainage time (days), median (25th-75th percentile)	3 (3-5)	4 (3-6)	3 (2-4)	0.004
– Hospital stay (days), median (25th-75th percentile)	5 (4-8)	6 (4-8)	4 (3-7)	0.03
– Rehospitalizations within 30 days after surgery, n (%)	13 (8.5)	12 (10.8)	1 (2.8)	0.18
Pathologic stage (patients with lung cancer)				
– Ia, n (%)	39 (25.5)	19 (16.7)	20 (51.3)	< 0.001
– Ib, n (%)	27 (17.6)	22 (19.3)	5 (12.8)	0.36
– IIa, n (%)	15 (9.8)	14 (12.3)	1 (2.6)	0.07
– IIb, n (%)	12 (7.8)	10 (8.8)	2 (5.1)	0.46
– IIIa, n (%)	26 (17)	21 (18.4)	5 (12.8)	0.42
– IIIb, n (%)	1 (0.7)	1 (0.9)	0 (0)	0.55
– IV, n (%)	1 (0.7)	1 (0.9)	0 (0)	0.55
Pathologic results				
– Adenocarcinoma, n (%)	89 (58.8)	64 (56.1)	25 (64.1)	0.38
– Epidermoid carcinoma, n (%)	9 (5.9)	6 (5.3)	3 (7.7)	0.58
– Carcinoid tumor, n (%)	6 (3.9)	5 (4.4)	1 (2.6)	0.61
– Sarcomatoid carcinoma, n (%)	5 (3.3)	5 (4.4)	0 (0)	0.18
– Adenosquamous carcinoma, n (%)	4 (2.6)	3 (2.6)	1 (2.6)	1
– Non-speci ed carcinoma, n (%)	3 (1.96)	3 (2.6)	0 (0)	0.57
– Mucoepidermoid carcinoma, n (%)	2 (1.3)	1 (0.9)	1 (2.6)	0.44
– Large cell neuroendocrine carcinoma, n (%)	1 (0.7)	0 (0)	1 (2.6)	0.25
– Basaloid carcinoma, n (%)	1 (0.7)	1 (0.9)	0 (0)	1
– Lymphoepithelioma-like carcinoma, n (%)	1 (0.7)	0 (0)	1 (2.6)	0.25
– Lymphoma, n (%)	1 (0.65)	1 (0.9)	0 (0)	1
– Metastasis, n (%)	9 (5.88)	8 (7)	1 (2.6)	0.44
– Benign pathology, n (%)	22 (14.4)	17 (14.9)	5 (12.8)	0.74

In patients whose diagnosis demanded lymph node sampling (n = 122), the number of lymph node station samples taken during surgery was statistically higher when the lobectomy had been performed by thoracotomy (4 versus 3.5 examined lymph node stations, $p < 0.001$).

Other statistically significant differences were found in the pleural drainage permanence time and in the length of hospital stay. Patients subjected to video-assisted thoracoscopic lobectomy had a shorter pleural drainage time (4 versus 3 days of pleural drainage, $p = 0.004$) and shorter length of hospital stay (6 versus 4 days of hospital stay, $p = 0.03$).

Discussion

Despite the lack of a prospective study validating the superiority of video-assisted thoracoscopic lobectomy in terms of postsurgical results, this approach has gained broad acceptance among thoracic surgeons when performing lung lobectomies. Several studies have shown, retrospectively, that video-assisted thoracoscopic lobectomy at least is not inferior to lobectomy via thoracotomy and has become the treatment of choice for patients with early-stage lung cancer [6-8, 11]. In the present series, video-assisted thoracoscopic lobectomies constitute 27% of the total lobar resections performed, similar to the percentage reported in the database of the Society of Thoracic Surgeons (STS) and other series [7, 12]. However, the use of this technique is very heterogeneously distributed in countries such as the United States, accounting for 40% in some regions and less than 20% [12] in others. We do not know of any study reporting the use of this approach by thoracic surgeons, neither in our country nor in Latin America.

In this series, video-assisted thoracoscopic lobectomies were performed more frequently in patients with stage IA lung cancer, thus reflecting our preference for this type of lobectomies in patients who come in for a consultation with clinical stage I lung tumor. Nevertheless, we observed a similar amount of patients with clinical stage I tumors that underwent a thoracotomy. This fact shows the surgeons' preferences regarding some patient in particular or the presence of other conditions indicating surgery via thoracotomy or lobectomies performed at the beginning of the series. At present, we suggest that most patients with stage I lung tumors with indication of lobectomy are offered a video-assisted thoracoscopic surgery.

There are many retrospective studies showing that video-assisted thoracoscopic lobectomies are associated with a lower incidence of postoperative complications when compared with the thoracotomy approach[5-9]. In the work of Subroto et al, about cases reported to the STS database, the authors found a lower amount of postoperative complications in patients who had received a video-assisted thoracoscopic lobectomy in comparison with thoracotomy (26 versus 35%, $p< 0.001$). Specifically, respiratory and cardiovascular complications (atrial fibrillation requiring treatment) had a lower incidence when the surgery was performed via video-assisted thoracoscopy [7]. In a similar way, Scott et al found in the secondary analysis of clinical trial Z0030,a lower amount of complications in patients who received surgery by means of video-assisted thoracoscopy (27 versus 48%, $p= 0.005$)[13]; also respiratory complications were less frequent. Also in this series, postoperative complications occurred globally in 30.7% of our patients. However, we did not observe a lower amount of postoperative complications in patients operated via video-assisted thoracoscopy. As opposed to other series, we found a significantly higher amount of patients who had received video-assisted thoracoscopy with atrial fibrillation; we do not have an explanation for these findings. We think that if we increase our samples, the incidence of atrial fibrillation should at least be similar in both groups.

The most frequent complication was prolonged air leak, which occurred in 12.4% of patients and was a determining factor of the length of hospital stay. This event prevented us from extracting the pleural drainage, thus affecting the postsurgical recovery in at least three ways: 1) the drainage causes pain and limits the movement of the patient and respiratory excursion; 2) the permanence of the pleural drainage can delay hospital discharge, although at present many of these patients are discharged using a Heimlich valve; 3) pleural drainage prolongation increases the risk of empyema. For that reasons, we think that the early removal of pleural drainage shortens recovery times. In our series, just like other authors [7], we found that the permanence of pleural drainage was shorter in patients operated via video-assisted thoracoscopy (3 versus 4 days).

The length of hospital stay of a patient who received a lobectomy may be prolonged due to the occurrence of complications, the permanence of the pleural drainage or the inability to manage the pain with oral medication. Our median length of hospital stay in patients who underwent a lobectomy was 5 days, similar to that reported in other series. In the group of lobectomies via video-assisted thoracoscopy, the length of hospital stay was significantly lower in comparison with that of the thoracotomy group (4 versus 6 days of postsurgical hospital stay). These findings coincide with the information published in some of the already mentioned series [6-9, 11].

At present, there is growing interest in moderating health care costs. Hospital care represents one third of health care costs in the United States [14] and a prolonged hospital stay has a negative and direct impact on this aspect of the economy. Also, postoperative complications and their severity increase in a direct way the cost of lung surgery [15]. The work of Swanson et al accounts for lower hospital costs of video-assisted thoracoscopic lobectomy[8]. While these results have not been confirmed in other studies [16], we believe it is an aspect to be taken into account. The lower frequency of complications observed in several studies with video-assisted thoracoscopic lobectomies, plus the shorter length of hospital stay could have a direct impact on hospital cost reduction.

Finally, one aspect that was discussed in several opportunities was the oncologic adaptation of video-assisted thoracoscopic lobectomies[5, 17]. One determining factor of prognosis in patients with lung cancer is the state of mediastinal lymph nodes. One surrogate measure of the correct lymph node staging is postsurgical stage migration in a tumoral disease. Boffa et al [17] report a lower migration of stage N0 to N1 when the lobectomy is performed by video-assisted thoracoscopy, but this is not the case with the migration of stage N1 to N2. The implication of these findings is that patients who are actually stage N1 could be considered as N0 and thus receive inadequate treatment. Due to the size of our series we weren't able to carry out a lymph node migration or survival study, but we observed that patients with indication of lymph node staging who were operated by video-assisted thoracoscopic lobectomy had a lower amount of collected lymph node stations in comparison with the cases of surgery via thoracotomy (4 versus 3.5 collected lymph node stations, $p < 0.001$). For that reason, we believe we should pay special attention to lymph node staging when the lobectomy is made via video-assisted thoracoscopic lobectomy.

Conclusion

We think that the results provided by the video-assisted thoracoscopic lobectomy are similar to those of the lobectomy by means of thoracotomy, in terms of complications and mortality. We suggest paying special attention during lymph node sampling with the video-assisted thoracoscopy approach. The main benefits for our patients, in favor of video-assisted thoracoscopic lobectomy are related to the shorter permanence of pleural drainage and a shorter length of hospital stay.

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