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Nosocomial infection following video-assisted thoracoscopic surgery

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ABSTRACT

Objectives: To assess the incidence and risk factors for nosocomial infection after video-assisted thoracic surgery (VATS).

Methods: Prospective cohort study of all consecutive patients who underwent VATS surgery during 20 months. Patients were visited on a daily basis and followed up until they were discharged from the hospital

Results: During the study period 217 patients (70.1% men; mean age, 50.9 years, range 15-85 years) underwent VATS. Fourteen (6%) episodes of postoperative infection were diagnosed in 13 patients, including pneumonia (n = 2), lower respiratory tract infection (n = 9), surgical site infection (n = 2), and urinary tract infection (n = 1). Prior inmunosupresion (adjusted odds ratio [OR], 2.70; 95% confidence interval [CI], 1.52-4.84), prior infections (OR, 14.9; 95% CI 1.91-116.5), preoperative stay > 2 days (OR, 3.37; 95% CI 1.00-11.40), neoplasia (OR, 3.69; 95% CI, 1.94-7.06) duration of surgery > 45 minutes (OR, 5.91; 95% CI, 1.00-36.40) and presence of central venous catheter (OR, 16.40; 95% CI, 2.29-117.20), were independent risk factors for nosocomial infection.

Conclusions: Nosocomial infection rate after VATS was low. Respiratory infection was the most common infection. Factors which affect patient immunity, preoperative stay and perioperative-related variables were independently associated with infection.

Key words: video-assisted thoracic surgery; postoperative infection; risk factors

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Infección nosocomial después de cirugía toracoscópica videoasisitida

RESUMEN

Objetivos: Estudiar la incidencia y los factores de riesgo de infección nosocomial en pacientes sometidos a una cirugía toracoscópica videoasistida.

Métodos*:* Estudio de cohortes prospectivo de todos los pacientes a los que se practicó una toracoscopia videoasistida durante 20 meses consecutivos. Los pacientes se visitaron diariamente hasta ser dados de alta hospitalaria.

Resultados: Durante el periodo de estudio se le practicó una toracoscopia videoasistida a 217 pacientes (70,1% hombres; edad media: 50,9 años, rango, 15-85 años). Se diagnosticaron 14 (6%) infecciones en 13 pacientes: 9 desarrollaron una infección de vías respiratorias bajas, 2 neumonía, 2 infección del sitio quirúrgico y 1 infección urinaria. En el análisis de regresión logística el tener una inmusupresión previa, (odds ratio [OR] ajustada: 2,70; intervalo de confianza [IC] 95%, 1,52-4,84), infección previa (OR: 14,9; IC 95% 1,91-116,5), estancia preoperatoria > 2 días (OR: 3,37; IC 95% 1,00-11,40), neoplasia (OR: 3,69; IC 95%, 1,94-7,06), duración de la cirugía > 45 minutes (OR: 5,91; IC 95%, 1,00-36,40) y la presencia de catéter venoso central (OR: 16,40; IC 95%, 2,29-117,20), se comportaron como factores independientes de riesgo de infección nosocomial.

Conclusiones*:* La tasa de infección nosocomial después de una cirugía toracoscópica videoasistida es baja. Las infecciones respiratorias fueron las más frecuentes. Los factores de riesgo independientes fueron los relacionados con la inmunidad previa del paciente, la estancia prequirúrgica y el momento perioperatorio.

Palabras clave: cirugía toracoscópica videoasistida; infección nosocomial; factores de riesgo

INTRODUCTION

Although thoracoscopy has been a part of thoracic surgical practice for many years, the advent of video-assisted techniques has greatly expanded the indications and the uses of this procedure[1-5]. Whereas previously thoracoscopy was performed mainly for diagnostic purposes, it now has assumed a major role in therapy of chest pathology[2-5]. The advantage of video-assisted thoracic surgery (VATS) over thoracotomy lies in the reduction of morbidity and mortality, acute and chronic postoperative pain and reduction of hospital stay[1-14].

The literature data about infections complicating VATS procedures are scarce and the incidence of infections in the VATS setting is not well defined, in spite of the increased of their application in recent years[6,13]. Studies about postoperative infection in patients undergoing VATS have showed a rate of 1 to 6%[6,13]. On the other hand, risk factors involved in these infections are not well established[6]. The purpose of this study was to describe nosocomial infection rates following thoracoscopic surgery, as well as the possible associated risk factors.

METHODS

Study design and setting. The study was carried out at a university-affiliated teaching hospital: Hospital Marqués de Valdecilla (900 beds), Santander, Spain. The Division of Thoracic Surgery perform approximately 350 thoracic procedures per year, 140 of these are VATS procedures. During a 20-month period (June 1, 1999 - January 31, 2001), all patients undergoing VATS surgery were potentially eligible for the study. Patients < 14 years of age, patients undergoing lung transplantation and if the thoracoscopy converted to a formal thoracotomy were excluded. The Institutional Review Board approved the study.

Data collection. Patients were visited on a daily basis to collect all data, which was recorded on a standardized data collection form. The following characteristics were prospectively recorded by one of the investigators: age; sex; body mass index; smoking history; alcohol consumption; presence of pulmonary disease (COPD); diabetes mellitus; hypoalbuminemia (serum albumin level < 3 g/L); anemia (hemoglobin < 12 g/dL); renal failure (serum creatinine level > 2 mg/dL); preoperative American Society of Anesthesiologists (ASA) physical status[15] FEV1; preoperative length of hospital stay; duration of surgery from the first skin incision until closure; type of lung surgery performed (lung wedge resection, lung biopsy, pleural procedures and mediastinal procedures); whether the surgery was performed on an emergent basis; blood transfusion; reoperation; placement of a central venous catheter; use of mechanical ventilation; use of a nasogastric tube; and urinary tract catheterisation (including dates of starting and ending). Postoperative care was consistent across patients. Standard measures included bronchial hygiene therapy started in the immediate postoperative period, which included aggressive chest physiotherapy, incentive spirometry, control of secretions, and early ambulation with exercising in the inpatient pulmonary rehabilitation unit. The surgeon indicated surgical prophylaxis. Antibiotic prophylaxis included the administration of cefotaxime, 2g q6h IV for 48 h (from June 1999 to December 1999), and amoxicillin/clavulanate, 1g q8h IV for 48 h (from January 2000 to January 2001). Other variables analyzed were local factors such as the presence of cancer in the histology. Hospital infections were identified through active concurrent surveillance and were diagnosed according to Centers for Disease Control and Prevention criteria[16, 17]. Major categories of infection included pneumonia, and lower respiratory tract infection. Pneumonia was diagnosed by the presence of new and/or progressive pulmonary infiltrates on chest radiography plus two or more of the following criteria: fever (> 38°C), leukocytosis (12 $X10^9$/L), purulent sputum, or isolation of pathogen in respiratory secretions. Lower respiratory tract infection was defined as the presence of purulent tracheobronchial secretions plus two or more of the following criteria: fever (> 38°C), leukocytosis (12 $X10^9$/L), or significant bacteriologic counts in respiratory secretions in patients without pulmonary infiltrates, suggesting pneumonia on the chest radiograph.

Statistical analysis. For each category of potential risk factors for infection, the incidence of nosocomial infection was calculated by dividing the number of events by the number of patients in each category. Relative risks (RRs) and their 95% confidence intervals (CIs) were calculated. All tests of significance were two tailed, and p values ≤ 0.05 were considered to indicate statistical significance. Multiple logistic regression analysis was performed to identify variables that were significantly related to the likelihood of developing nosocomial infection. Potential predictor variables for model entry were identified using univariate analysis. Regression models were controlled for the effects of confounding variables. Results of the logistic regression analysis are reported as adjusted odds ratios (ORs) with 95% CIs. Statistical analyses were performed using Stata version 8.0 (Stata Corporation; College Station, TX).

RESULTS

Patients. A total of 217 consecutive patients undergoing VATS procedures were prospectively evaluated. The mean age of the patients was 50.9 years (range, 15 to 85); 152 (70.1%) patients were men. The mean (± SD) preoperative stay was 3.9 ± 5.2 days. The surgical procedures performed on these patients included 37 (17.1%) lung resections, 48 (22.1%) lung biopsies, 58 (26.7%) pleural procedures and 74 (34.1%) mediastinal procedures. The mean duration of surgery was 39.4 ± 26.6 minutes. Five patients (2.3%) died during their hospitalization following thoracoscopic surgery.

Incidence of nosocomial infection. Thirteen (6.0%) patients developed at least one nosocomial infection. Twelve patients had only one infection and one patient had two infections. The distribution of infections was: 11 respiratory, 2 surgical site

Table 1 **Preoperative variables analyzed as potential risk factors for postoperative infection.**

	Total Patients	Nosocomial Infection (n =13)		
Variable	n	n (%)	RR (95% CI)	OR (95% CI)*
Age > 65	52	4 (7.69)	1.03 (0.30-3.46)	0.61(0.13-2.90)
Male gender	152	7 (4.61)	0.68 (0.23-2.01)	0.87(0.23-3.27)
Smoking status				
Never-smoker	79	6 (7.59)	1	1
Ex-smoker	42	3 (7.14)	0.94 (0.25-3.57)	1.58 (0.28-8.89)
Smoker	96	4 (4.17)	0.55 (0.16-1.88)	0.46 (0.10-2.13)
Alcohol consumption	158	11 (6.96)	0.49 (0.11-2.13)	0.61 (0.74-4.93)
Preoperative hospital stay †				
1-2 days	149	5 (3.36)	1	1
≥ 3 days	68	8 (12.5)	3.51(1.19-10.32)	3.37 (1.00-11.40)
Anemia	29	5 (17.24)	4.05 (1.42-11.54)	2.04 (0.33-12.53)
(hemoglobin <12 g/dL)				
Prior radiotherapy	6	1 (16.67)	2.93 (0.45-19.05)	1.99 (0.13-30.25)
Immunosuppressive	16	3 (18.75)	3.77 (1.15-12.33)	4.90 (1.05-22.99)
therapy				2.17 (0.29-16.25)
Renal failure	21	2 (9.52)	1.53 (0.36-6.49)	
Previous infection	6	2 (33.33)	6.39 (1.80-22.76)	14.9 (1.91-116.5)
Neoplasia	76	9 (11.84)	4.17 (1.33-13.11)	9.25 (1.62-52.75)

RR: risk ratio; OR: odds ratio; CI: confidence interval.

*Adjusted for age, gender, smoking status, prior infection, neoplasia, immunosupresant drugs and preoperative hospital stay.

† Mantel-Haenzel $\chi 2$ test for trend, p = 0.133.

infections and 1 urinary infection. Of the respiratory infections, 2 were in the form of pneumonia and the remaining 9 were of the lower respiratory tract. Surgical site infection rate was 0.9%. Both of the surgical site infections were superficial. Only 2 (15.4%) of the infected patients (pneumonia) developed sepsis.

Microorganisms were isolated in both of the surgical site infection (*Staphylococcus aureus)* and in only 2 of the respiratory infections (*Staphylococcus aureus* and *Haemophilus influenzae*).

None of the patients who developed a nosocomial infection died, but they required a longer hospital stay (19.1 $\pm$ 9.1) than those who remained infection-free (7.6 $\pm$ 8.0), which was statistically significative ($p < 0.001$).

Antibiotic prophylaxis. A total of 91 (41.9%) patients received perioperative antibiotic prophylaxis: 42 patients with cefotaxime, 47 patients with amoxicillin/clavulanate and 2 patients with other regimens due to penicillin allergies or intolerance. Antibiotic prophylaxis was used in 67.6% of lung resection, 48.3% of pleural procedures, 39.6% of lung biopsies and 25.7% of mediastinal procedures.

Risk factors. With regard to preoperative variables (table 1), immunosuppressive therapy prior to surgery (OR, 4.90; 95% CI, 1.05 to 22.99), previous infection (OR, 14,9; 95% CI, 1.91 to116.5), preoperative stay ≥ 3 days with an increased risk for each additional day (Mantel-Haenzel $\chi 2$ test for trend, p = 0.002) (OR, 3.37; 95% CI, 1.0 to 11.4) and the diagnosis of cancer (regarded to the tissue removed during surgery) (OR, 9.25; 95% CI, 1.6 to 52.7) were risk factors for nosocomial infection. COPD, diabetes, body mass index, hypoalbuminemia, and renal failure as well as the preoperative anemia were not identified as risk factors for the development of nosocomial infection. In relation to intraoperative events (table 2), only the duration of surgery > 45 minutes (OR, 5.91; 95% CI, 1.0 to 36.4) was a risk factor for nosocomial infection. Perioperative antibiotic prophylaxis did not influence the risk of nosocomial infection. The rate of nosocomial Infection was similar in patients who received (6.6%) or not (5.5%) antibiotic prophylaxis. Pulmonary wedge resection was associated with a higher risk of nosocomial infection compared to other types of surgery, although the OR was not statistically significant (OR, 34.17; 95% CI, 0.85-1371.9). The analysis of postoperative variables (table 3)

Table 2 **Perioperative extrinsic risk factors analyzed for postoperative infection.**

	Total Patients	Nosocomial Infection (n =13)		
Variable	n	n (%)	RR (95% CI)	OR (95% CI)*
Antibiotic Prophylaxis	91	6 (6.59)	1.19 (0.41-3.41)	1.18 (0.26-5.33)
Type of operation				
lung biopsy	48	1 (2.08)	1	1
lung wedge resection,	37	5 (13.51)	6.49 (0.79-53.2)	34.17(0.85-1371.9)
pleural procedures	74	4 (5.40)	2.59 (0.30-22.5)	9.01 (0.24-332.0)
mediastinal procedures	58	3 (5.17)	2.48 (0.27-23.1)	7.34 (0.23-237.9)
Clean-contaminated surgery	6	1 (16.67)	2.93 (0.45-19.05)	2.02 (0.11-34.83)
Length of surgery, min†				
< 25	89	2 (2.25)	1	1
25-30	30	1 (3.33)	1.48 (0.14-15.78)	1.17 (0.09-15.01)
31-45	44	4 (9.09)	4.05 (0.77-21.24)	3.83 (0.59-25.08)
<45	54	6 (11.11)	4.94 (1.03-23.63)	5.91 (1.00-36.40)

RR: risk ratio; OR: odds ratio; CI: confidence interval.

*Adjusted for age, gender, smoking status, prior infection, neoplasia, immunosuppressive therapy, preoperative hospital stay and duration of surgery.

† Mantel-Haenzel $\chi 2$ test for trend, p = 0.002.

showed that the presence of a central venous catheter (OR, 16.4; 95% CI, 2.3 to 117.2), irrespective of days of catheter insertion, was an independent risk factor for the development of a nosocomial infection.

DISCUSSION

In spite of the increased application of VATS in recent years, there are few data available about infectious complications following VATS procedures[6, 13]. In the present study, 6% of VATS patients developed a postoperative infection. These results are similar to those described by Rovera et al[13]. The most frequent type of infection identified was the infection of respiratory system, followed by the surgical site. In addition, the most serious manifestation of these infections was nosocomial pneumonia and its associated sepsis. These findings agree with previous studies of sepsis in surgical patients[18]. Although the post-VATS mortality rate was 2.3%, none of these deaths was due to infection. Despite the fact that the literature describes empyema rates of 0.4-1.4% in patients undergoing VATS procedures[12,13], none of the patients in this study suffered from this complication. This prospective study demonstrated that the surgical site infection rate after VATS (0.9 %) is much lower than following open thoracotomy[19, 20] and similar to that found by other studies about VATS[6,13].

In our study, age was not found to be a risk factor for postoperative infection. More recently, researchers have indicated a low level of pulmonary complications among older patients in lung surgery but[21], nevertheless a greater correlation has been found between the infectious complications and the comorbility of the patient, as has been the case in our study.

Treatment with immunosuppressors prior to surgery was shown to be a risk factor for postoperative infection. In the Rovera et al.[13] study, although this variable was included in the set of comorbility factors, it did not behave as a risk factor for infectious complications. However, there are studies which show that increased postoperative morbidity and mortality after surgery, possibly due to the fact that immunosuppressors treatment caused a transient and a relatively permanent immune deficit favouring the appearance of infections[22]. Another independent risk factor for nosocomial infection was the presence of an infection prior to the VATS. In thoracic surgery, this has proved to be a risk factor for empyema and pneumonia because a prior infection may not be sufficiently cured, or the treatments used may have selected a microbial flora which is more aggressive and resistant to chemoprophylaxis[23].

Thoracoscopic surgery is used especially as a diagnostic technique for cancer patients, which this study showed to be an important intrinsic factor for the development of postoperative

infection. The presence of cancer increases the risk of infection because of the immunosuppression resulting from the illness itself as well as the chemotherapeutic treatments and diagnostic and therapeutic manoeuvres which these patients undergo. A certain level of colonisation by germs from the normal respiratory flora is also frequently associated with pulmonary cancer, favouring the appearance of postoperative infection[14,22,24]. Although the preoperative risk factors found (immunosurpression, cancer and prior infection) seem to be related, logistic regression analysis showed them as independent risk factors.

Preoperative hospital stay was identified by multivariate analysis as the predictor of nosocomial infection. Numerous other studies also show an increased infection rate associated with a lengthy hospital stay prior to surgery[25, 26]. One explanation could be that the patients who await an operation in hospital for a considerable time tend to be the most serious cases, and are consequently subjected to invasive therapeutic procedures. Also, antibiotic-resistant microbes may colonize these patients during their time in hospital. There is, however, no consensus as to the exact number of days after which this increased risk begins. In our study the risk rises in direct progression as of the second day. This is a modifiable risk on which to work in order to prevent nosocomial infection undergoing VATS.

Among the surgical risk factors the only one behaving as an independent risk factor was the duration of the operation. The risk of infection significantly increased when surgery lasted for more than 45 minutes. Although it is a risk factor which has been widely demonstrated in other operations, it had not been associated with postoperative infection following VATS[13]. Lung edge resection was the type of surgery that showed a higher risk of nosocomial infection, although the difference did not reach statistical significance, probably due to a lack of statistical power. This finding agrees with other studies that showed poor outcome for this procedure[27].

Antibiotic prophylaxis in open thoracotomy is controversial, although their use is extended. Lung resection without any proof of infection is classified as "clean contaminated" due to the opening of the bronchus during the procedure. While the controlled trials concerning the antibiotic prophylaxis demonstrated the significant reduction of wound infections in patients undergoing lung resection, no effect on deep infections such as bronchopneumonias or empyemas has previously been shown[28]. The benefit of VATS procedures is the decrease in surgical trauma, reducing surgical morbidity and infectious complications. The use of antibiotic prophylaxis in these operations remains an unsettled issue[13]. In our review we found no differences between the group given antibiotic chemoprophylaxis and the group to whom it was not administered. Neither was any distinction to be made between the two regimens employed.

Among the postoperative invasive manoeuvres, only the placement of a central venous catheter behaved as an independent risk factor. Although its association with the presence of nosocomial bacteraemias has been demonstrated[19], our study has not observed any episodes of bacteraemia. It is possible that the central catheter was placed in patients who were subjectively seen to be in potential need of endovenous medication or possibly have postoperative complications. These characteristics have not been specifically examined and perhaps they are the ones that favoured the appearance of infectious complications.

Some limitations of this study should be addressed, such a small sample size that may lack the statistical power to detect some associations. This could have avoided the identification of some risk factors for nosocomial infection, mainly those with small influence.

In summary, nosocomial infections occurred in 6% of patients who underwent VATS, and those of the respiratory system remain the most important in terms of frequency and morbidity. Factors related to the patient's immunity (presence of cancer, immunosuppressive treatment and the existence of an infection prior to surgery), together with extrinsic factors depending on hospitalisation such as the preoperative stay, the duration of the operation and the placement of a central venous catheter, were independent risk factors for infection following VATS.

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