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Diagnostic and therapeutic performance of video-assisted thoracoscopic surgery (VATS) in investigation and management of pleural exudates

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ABSTRACT

INTRODUCTION Video-assisted thoracoscopic surgery (VATS) is the gold standard investigation for diagnosis of pleural exudates. It is invasive and it is important to ensure that it is performed to acceptable national standards. We assumed that VATS empyema fluid culture would not contribute further to microbiological diagnosis in referred culture-negative empyemas.

PATIENTS AND METHODS Eighty-six consecutive external referrals for VATS for diagnosis of a cytology-negative pleural exudate (or for further management of the exudate) were studied retrospectively. Diagnostic yield, pleurodesis efficacy and complications were compared to national standards and good practice recommendations. VATS empyema fluid microbiological culture results were compared to pre-VATS empyema fluid culture results.

RESULTS VATS was performed well within national standards with a diagnostic yield of 82.3% for cytology-negative exudates, 100% pleurodesis efficacy, 5.8% postoperative fever, with only one significant complication (1.2% rate) and no deaths. Compliance with good practice pleural fluid documentation points was greater than 70%. VATS empyema fluid culture positivity (84.6%) was significantly higher than pre-VATS fluid culture (35%).

CONCLUSIONS VATS was performed to acceptable standards. These data confirm the utility and safety of VATS in the right context but also suggest the potential diagnostic utility of VATS empyema fluid culture. Further studies are required to investigate this latter possibility further.

KEYWORDS

VATS – Pleural exudate – Malignancy – Empyema – Audit

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Pleural effusion is a very common medical presentation for a range of potentially serious underlying diseases. Diagnosis of an unexplained pleural exudate is one of the key challenges in pleural disease. The particular concern is of underlying malignancy, which is important to diagnose as it will impact on survival time and treatment options.[1] In addition, as malignant mesothelioma is in the differential, it is important to minimise the number of needle insertion tracks as 40% of these are subsequently invaded by tumour.[2]

Many non-surgical investigations of malignant pleural effusion are hampered by their limitations. Pleural fluid cytology achieves a mean diagnostic yield of 60%,[3] although taking a second sample can further increase the yield by up to 27% in some studies, this has time implications.[4] Abrams closed pleural biopsy in the best hands (with 4 biopsies) may increase the diagnostic yield over cytology by 7–27% at best and can be associated with significant morbidity.[3] CT-guided biopsy is useful for improving diagnostic yield (88–93% rate) but introduces further delay, as the effusions cannot be managed at the same time.[5]

Video-assisted thoracoscopic surgery (VATS) is the gold standard investigation of an unexplained pleural exudate, achieving a diagnostic yield of 90–95% for unselected effusions.[6] It also allows management of the effusion with effective pleurodesis (rates of greater than 90% with talc). Due to the requirement for general anaesthesia, its relative invasiveness and the need for thoracic surgical expertise, VATS is often only performed after initial pleural cytology and closed biopsy have been attempted (which will diagnose 60–75% of cases). In the remaining 25–40% of cytology-negative effusions, VATS still achieves a diagnostic yield of 70%.[7]

We audited the performance of our VATS thoracic surgical service in the investigation and management of undiagnosed

pleural exudates, as compared to expected standards from The Royal College of Surgeons of England (RCSE), Society for Cardiothoracic Surgery in Great Britain and Ireland (STS) and British Thoracic Society (BTS).[8–11] We also audited performance against the BTS good practice pleural fluid documentation standard.[10] Finally, we compared the pleural fluid culture positivity rate from VATS empyema fluid to that obtained at pre-referral, based on the assumption that the VATS empyema fluid rate would be non-contributory to microbiological diagnosis.

Patients and Methods

A retrospective audit and review of the VATS service for diagnosis and/or management of a pleural exudate at Derriford Hospital, Plymouth, UK was performed. Referrals from only external hospitals were included (not on site referrals).

Case records from 86 consecutive external referrals for VATS were obtained. Data were collected on demographics (age, gender) and length of hospital stay. Primary audit points were diagnostic yield of VATS, efficacy of pleurodesis and complications compared to standards from the Society of Cardiothoracic Surgeons in Great Britain and Northern Ireland (SCTS) and British Thoracic Society (BTS; Table 1A). Additional secondary audit points were documentation of the pleural fluid volume and appearance based on the good practice points from the BTS (Table 1B). Other points of interest included the sclerosant type, VATS empyema fluid culture positivity, total bed stay, and the number of non-diagnostic procedures performed pre-referral.

Statistical analysis was performed using Graph Pad Prism v.4 software. Contingency data are represented as proportions or percentages. Odds ratios and 95% confidence intervals are quoted with *P*-values. A *P*-value of less than 0.05 was deemed significant.

Table 1 (A) Standards for thoracoscopy (SCTS/BTS), primary audit points

Audit points	Expected standard (%)
Diagnostic yield for pre-investigated pleural exudate	> 70 (90–95 for uninvestigated exudates)
Efficacy of pleurodesis	> 90 (with talc)
Mortality	< 1.6
Major complications	< 2
Fever	< 16
Subcutaneous emphysema	< 7
Air leak > 7 days	< 2
Severe arrhythmia	< 0.4
Severe haemorrhage	< 0.2
Air embolism	< 0.2

Table 1 (B) Secondary audit points, good practice BTS

Audit points	Expected standard (%)
Record pleural fluid volume	100
Record pleural fluid appearance	100

Results

Demographics and background

Patient demographic data are shown in Table 2. There was a male preponderance, with mean bed-stay of 8.8 days. A total of 86 cases were referred (having had 159 pre-referral diagnostic procedures), 62 for diagnosis and 24 for further management of the effusion (including 20 empyemas). As expected, the commonest diagnosis was malignancy (71%), most commonly non-small cell lung cancer (24.2%), mesothelioma (22.6%) and metastatic disease (16.1%).

Primary audit points

Performance against the primary audit points is shown in Table 3. The Derriford VATS service met all the national standards, well within the mortality requirements (no deaths occurred) and expected occurrences of fever or subcutaneous emphysema. The only significant complication was one occurrence of complete heart block which was treated successfully.

The 82.3% diagnostic yield (Table 3) is stringent as it does not include an additional 12.9% following VATS who were thought to have probable (but not definite) diagnosis. These probable diagnoses were all inflammatory effusions with no evidence of malignancy for the period of prolonged follow-up in suspected malignant pleural disease.

Table 2 Demographic data and length of stay

Parameter	Mean (SE) [*n* = 86]	95% CI
Age (years)	61.4 (1.6)	58.2–64.6
Gender (%)	M:F 57:43	N/A
Bed-stay (days)	8.8 (0.5)	7.8–9.9

Table 3 Performance against primary audit points

Audit points	Observed (%)	Expected (%)	OR (95% CI)	*P*-value
Diagnostic yield	82.3*	> 70	1.99 (0.91–4.330	0.10
Efficacy of pleurodesis	100	> 90	8.00 (0.46–140.5)	0.06
Mortality	**0**	**< 1.6**	**0.04 (0.002–0.59)**	**< 0.0001**
Major complications	1.2	< 2	0.58 (0.14–3.58)	1.00
Fever	**5.8**	**< 16**	**0.32 (0.11–0.90)**	**0.04**
Subcutaneous emphysema	**0**	**< 7**	**0.07 (0.004–1.28)**	**0.02**
Air leak > 7 days	0	< 2	0.23 (0.01–4.81)	0.50
Severe arrhythmia	**1.2**	**< 0.4**	**3.52 (1.13–10.97)**	**0.02**
Severe haemorrhage	0	< 0.2	0.23 (0.01–4.85)	0.50
Air embolism	0	< 0.2	0.23 (0.01–4.85)	0.50

*Diagnostic yield shown for definite cases only. This increases to 95.2% if probable diagnoses included (see text for discussion).

Therefore, the effective diagnostic yield improves to 95.2% for definite and probable cases combined.

Additional self-limiting complications included mild electrolyte disturbances, ileus and allergy (8.1%), transient air leaks (3.5%), atrial fibrillation (2.3%), and clinically insignificant haemorrhage (1.2%).

Secondary audit points

Documentation of pleural fluid volume and appearance in concordance with BTS good practice statements was above 70% but significantly below 100% (Table 4).

Other points

The microbiological yield of pleural fluid cultures for diagnosed empyema before referral was 35%. Of the culture-negative empyemas at the time of referral, there was a significant increase in pleural fluid culture positivity after VATS to 84.6% (Table 5).

Discussion

These data confirm that, in our hospital, VATS achieved the required standards in diagnosis, pleurodesis and safety. No deaths occurred which is well within the national standard of less than 1.6% mortality for VATS pleural procedures (*Society for Cardiothoracic Surgery in Great Britain and Ireland Thoracic Surgical Register for 2002–5*).[9]

In addition, the number of episodes of fever and subcutaneous emphysema were well within national standards. Documentation of pleural fluid met BTS standards in over

Table 4 Performance against secondary audit end-points

Audit points	Observed (%)	Expected (%)	OR (95% CI)	*P*-value
Record pleural fluid volume	72.1	100	0.013 (0.001–0.21)	< 0.0001
Record pleural fluid appearance	81.4	100	0.02 (0.001–0.36)	< 0.0001

Table 5 Empyema pleural fluid culture pre- and post-referral

Parameter	VATS pleural fluid (%)	Pre-referral pleural fluid (%)	OR (95% CI)	*P*-value
Pleural fluid culture positive	84.6	35	10.2 (1.75–59.7)	0.01

70% of cases. VATS empyema fluid culture achieved a significantly higher microbiological yield than pre-referral empyema fluid culture.

The diagnostic yield for malignant effusions in this study compares favourably with previously investigated cytology-negative effusions.[7] Taking into account the probable diagnoses, VATS achieved a diagnostic yield of 95.2% in this study which is equivalent to the expected performance of VATS for uninvestigated effusions.[6,7]

The superiority in microbiological culture results on VATS empyema fluid rather than pre-VATS was unexpected and is not consistent with the literature. Pleural fluid culture positivity varies with the stage of pleural infection between 30% and 75% with higher yields in the empyema stage.[12] Why was a discrepancy noted between VATS and pre-VATS empyema fluid culture rates in our study? Possible explanations include a greater bacterial burden at a later stage of pleural infection, a longer antibiotic-free time in culture-negative empyemas referred for VATS (detailed antibiotic data were not available to audit) or a higher incidence of introduced infection at the time of pre-VATS fluid culture.

This study has confirmed the diagnostic and therapeutic utility as well as the safety of VATS in our centre. Diagnostic yield was stringently assessed by not including probable cases of benign disease. This may have underestimated the true diagnostic yield of VATS in our study. We have also raised the possibility of VATS having an additional beneficial role in obtaining empyema fluid culture positivity.

Study limitations

There are some limitations to this retrospective study. It was not prospective, controlled or powered to answer the question of microbiological yield and data on the timing of antibiotic therapy were not available. It is also not possible to discount failures in pleurodesis efficacy after the time of follow-up but this is a problem in all such studies.

Conclusions

This study adds to the substantial data that VATS is the gold standard investigation for diagnosis of cytology-negative suspected malignant pleural effusions, and also provides optimal management for pleurodesis or empyema drainage when medical management has failed. Our VATS service is well within expected national standards. Future adequately powered controlled studies are needed to assess whether VATS empyema fluid does indeed achieve superior microbiological yield and whether this translates in improved patient outcomes in terms of antibiotic modifications, length of stay, quality of life measures and mortality.

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