Single-Center Experience With 250 Tunnelled Pleural Catheter Insertions for Malignant Pleural Effusion*

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Introduction: Malignant pleural effusions (MPEs) are a common cause of dyspnea in patients with advanced cancer. Tunnelled pleural catheters (TPCs) can be used in patients with this condition, but the published experience with them is limited.

Objective: To describe the use of TPCs in the management of MPE in a large group of patients in a clinical setting.

Methods: Retrospective analysis of 250 sequential TPC insertions in patients with MPEs in a single center.

Results: Two hundred fifty TPC procedures for MPE were performed in 223 patients (19 contralateral procedures and 8 repeat ipsilateral procedures) during a 3-year period. Symptom control was complete following 97 procedures (38.8%), was partial in 125 procedures (50%), and was absent in 9 procedures (3.6%); in addition, there were 10 failed TPC insertions (4.0%) and 9 TPC insertions (3.6%) without assessment of symptoms at the 2-week follow-up visit. Spontaneous pleurodesis occurred following 103 of the 240 successful TPC procedures (42.9%) and was more frequent when ≤ 20% of the hemithorax contained fluid at the 2-week follow-up visit (57.2% vs 25.3%, respectively; p < 0.001). Catheters stayed in place for a median duration of 56 days. Following successful TPC placement, no further ipsilateral pleural procedures were required in 90.1% of cases. The overall median survival time following TPC insertion was 144 days.

Complication rates were low and compared favorably with those seen with other treatment options.

Conclusions: TPC placement is an effective method of palliation for MPE that allows outpatient management and low complication rates. The insertion of a TPC should be considered as a first-line treatment option in the management of patients with MPE.

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Key words: dyspnea; lung cancer; malignancies; pleural effusion

Abbreviations: CI = confidence interval; CXR = chest radiograph; MPE = malignant pleural effusion; SP = spontaneous pleurodesis; TPC = tunnelled pleural catheter

Malignant pleural effusion (MPE) is a common complication of malignant disease, which can lead to significant morbidity and impairment in quality of life. Dyspnea, which is found in 50% of affected patients, is by far the most important symptom caused by MPE.¹ It is thought that for most malignancies the presence of an MPE precludes a cure and is associated with high mortality. For example, the survival time for patients with stage IIIB lung cancer with MPE has been reported as 7.5 months,² although for certain tumors such as lymphoma the prognosis is not as dire.³

In view of the morbidity attributable to MPE and of the nature of the patient population experiencing it, an ideal treatment approach should offer immediate and long-term relief of symptoms, avoid hospitalization, be applicable to the majority of patients, have minimal side effects, and avoid repeated un-
comfortable procedures. Clearly, none of the current MPE treatment options have all of these characteristics.

A novel approach to the treatment of MPE with the use of a chronic indwelling tunnelling pleural catheter (TPC) [Fig 1] for intermittent fluid drainage has been reported to be effective in the palliative treatment of patients with MPE. The use of TPCs has gained popularity over the past few years, but the overall published experience with this approach remains limited. We report our experience with this technique with a retrospective analysis of the first 250 TPC insertions for the treatment of MPE performed in our center, which represents the largest number of cases studied and published to date.

Materials and Methods

Overview

TPCs were introduced in our center in October 2001. In order to evaluate this new treatment approach, a prospective database was developed and maintained to track procedure volumes, short-term results, and complications. The database was closed in November 2004 after 250 procedures had been logged. A retrospective review of all procedures and records was performed with the approval of the Conjoint Health Research Ethics Board of the University of Calgary.

Clinical Approach

The use of TPCs in this center was implemented by pulmonary physicians in association with the regional cancer center. A weekly outpatient clinic was established to which patients with malignant pleural disease were referred and where they were evaluated by a pulmonologist in the clinic, who was supported by a dedicated clinic nurse as well as specialized palliative care support. Patients with recurrent symptomatic MPE were offered TPC treatment (Pleurx catheter; Denver Biomedical Inc; Denver, CO). TPCs were inserted under local anesthesia in the clinic without ultrasound guidance in the large majority of patients, although bedside ultrasound became available during the final year of this study. Given the volume of referrals, and in order to minimize wait list for the clinic, the initial consultation took place outside the specialized clinic, and the TPC was inserted in a procedure room/bronchoscopy suite as an outpatient procedure. Last, although a subset of the patients was in the hospital at the time of consultation and TPC placement, patients were not admitted to the hospital simply for TPC placement. Regardless of the site of the initial TPC placement, all patients were scheduled for a follow-up visit and chest radiograph (CXR) in the specialized clinic at 2 weeks, then every 6 to 8 weeks thereafter and on an as-needed basis. Patients were followed up in the clinic until TPC removal or death.

Home care nursing support was organized for all patients to assist TPC care and drainage. Palliative home care nursing staff in the Calgary Health Region received specific education sessions at the onset of the program, while individual contact was made when referring to home care staff outside the region. Drainage of the catheter was performed as tolerated at the time of TPC placement and subsequently three times weekly at home, allowing flexibility in the frequency and volume drained according to symptoms and the volume of fluid. TPCs were removed once the volume of fluid drained was <50 mL on three sequential drainage attempts and fluid reaccumulation was not detected on a CXR.

Procedure Database

The initial prospective database was maintained by the authors. The database included the following information: patient identification; gender; age; primary malignancy; size of the effusion on pretreatment CXR; side of effusion; dates of insertion; removal; death (if known); complications; and symptom control at the 2-week follow-up visit (ie, complete, partial, or absent).

The retrospective review aimed to corroborate the data points that had been prospectively entered and added the following data points: size of effusion on CXR 2 weeks postprocedure; ipsilateral pleural procedures performed prior to insertion of the TPC; ipsilateral pleural procedures performed following TPC treatment; contralateral TPC placement; and the date of the last follow-up visit at the cancer center if the patient was still alive.

The retrospective review was performed by the following methods: (1) manual review of the pulmonary office chart; (2) review of computerized cancer center records, including reliable data on the date of death; and (3) review of diagnostic imaging Web archives for the Calgary Health Region, including information on image-guided thoracentesis and chest tube placement.

Definitions

The 250 TPC procedures that were analyzed for this study include all sequential TPC insertions in patients with known or
highly suspected MPE from the onset of the availability of this procedure in our center. During this time period, five TPCs were inserted for nonmalignant diagnoses and are not included in this analysis.

All dates were calculated from the day of TPC insertion unless stated otherwise. Spontaneous pleurodesis (SP) was said to occur when the drainage volume decreased to < 50 mL of fluid for three consecutive drainage attempts without progressive symptoms or the reaccumulation of fluid on a CXR. The date of SP was calculated according to the date of TPC removal and not the date on which fluid stopped draining. Dyspnea control was determined at the 2-week follow-up evaluation and was described on a simple 3-point scale as complete, if the patient noted the absence or minimal presence of symptoms, partial, if the patient described significantly improved but persistent dyspnea, and absent, if no significant improvement of dyspnea was noted. We did not differentiate between other contributing causes of dyspnea unless there was complete reexpansion of the lung and the absence of residual fluid.

The size of the effusion was analyzed semiquantitatively by one of the investigators as a fraction of the hemithorax filled with fluid prior to TPC insertion and at the 2-week follow-up visit on a standard posterior-anterior and lateral CXR. The patient was deemed to have an adequately reexpanded lung if ≤ 20% of the treated hemithorax contained fluid at 2 weeks. Patients were considered to have received significant prior ipsilateral pleural intervention if they had received any of the following: more than two therapeutic thoracentesis procedures; a chest tube; chemical pleurodesis; thoracoscopy; or prior TPC insertion. Complications as well as any ipsilateral pleural procedures required post-TPC placement were also recorded.

Statistical Analysis

All data were entered into spreadsheet format in a statistical software program (SPSS, version 13.0; SPSS; Chicago, IL). Patient identifiers were deleted from the database once the chart review was completed. Descriptive statistics were used to summarize patient characteristics, SP rates, symptom control rate, size of the effusion, complication rates and repeat procedures.

All statistical analyses were performed considering a p value of < 0.05 as being statistically significant. The impact of nominal factors on symptom control, SP, and complications were assessed with the χ² test or Fisher exact test, as appropriate. Survival data were analyzed using the Kaplan-Meier method, and pairwise comparisons were determined with the log-rank and Breslow methods.

RESULTS

Between October 2001 and November 2005, 250 TPC procedures for the management of patients with MPEs were performed in 223 patients (19 contralateral procedures and 8 repeat ipsilateral procedures). At the time of analysis, all patients had died or had the TPC removed except for two patients, one of whom had undergone bilateral TPC insertion. Patient demographic data and tumor cell type are described in Table 1.

Symptom Control

Symptom control at the 2-week follow-up visit was recorded as complete following 97 procedures (38.8%), partial in 125 procedures (50%), and none in 9 procedures (3.6%). In addition, 10 TPC insertions failed (4.0%), and in 9 other cases (3.6%) symptom control could not be assessed because the patient died within 2 weeks or could not attend the follow-up appointment. No statistically significant differences in symptom control were found overall according to primary tumor type, although a trend for more frequent complete symptom control was found in breast cancer patients (53.3%) and less frequent complete control was found in lung cancer patients (31.1%).

The size of the effusion was significantly decreased from baseline to the 2-week follow-up visit (61 to 23% overall, respectively; p < 0.001 [paired t test]). The size of the effusion at week 2 (but not at baseline) significantly correlated with the degree of symptom control (complete control, 13%; partial control, 30%; absent dyspnea control, 59%).

SP and Length of Pleural Drainage

SP occurred following 103 of the 240 successful TPC procedures (42.9%), and an additional 7 patients (2.9%) eventually received a sclerosing agent through the TPC. Fifteen additional catheters (6.3%) were removed for various reasons (empyema, five patients; subcutaneous emphysema, one patient; drainage stopped but symptomatic loculation, three patients; dislodged, three patients; “trapped lung” with no improvement in symptoms, one patient; pain, one patient; and extrapleural placement, one patient).

No statistically significant impact of tumor cell type, side of occurrence, or size of effusion at baseline, age, or gender was found to exist on the
incidence of SP. TPC placement resulting in ≤ 20% fluid remaining in the hemithorax at the 2-week follow-up visit was significantly more likely to result in SP (57.2% vs 25.3%, respectively; p < 0.001).

One hundred ten TPCs (45.8%) stayed in place until death, and 3 TPCs remained in two patients at the time of analysis (after 119, 140, and 202 days of follow-up). Overall, the TPC remained in place for a median of 56 days (95% confidence interval [CI], 47 to 65 days) until death or TPC removal. In patients achieving SP, the median time to catheter removal was 59 days (95% CI, 46 to 72 days).

Requirement for Repeat Pleural Procedures

Following successful TPC placement, no further ipsilateral pleural procedures were required in 90.1% of cases. Repeat procedures performed following TPC insertion in the remaining 9.9% were as follows: repeat TPC placement, nine patients; thoracentesis, six patients; standard chest drain, five patients; and pleural fibrinolysis, four patients.

In the 103 TPC cases in which patients achieved SP, repeat procedures following TPC removal were required in only 9 (8.7%; thoracentesis, 4 cases; repeat TPC, 4 cases; chest tube placement, 1 case), with a mean follow-up period or time to death of 221 days and a median follow-up period or time to death of 128 days. In 19 cases, a TPC was placed for treatment of a contralateral MPE. Symptom control was not different in this subgroup, but the frequency of SP trended toward lower probability than in those undergoing ipsilateral procedures (21.1% vs 42.9%, respectively; p = 0.063).

Complications

Complications related to the TPC are listed in Table 2. These include one episode of recurrent effusion and one case of empyma, which occurred after the use of talc slurry via a TPC that was already in place.

An analysis of the first 200 TPC procedures performed by a single physician suggested no change in overall complications rates according to quartiles of the number of procedures performed. The number of failed insertions decreased over the four quartiles (10%, 8.2%, 0%, and 2%, respectively; p = 0.025).

Impact of Prior Pleural Procedures

The performance of 63 TPC procedures (25.2%) was preceded by pleural interventions. No statistically significant differences in symptom control, rate of SP, and overall complication rates were noted, although a trend toward the increased incidence of failed TPC insertion in the previously treated group was noted (odds ratio, 3.14; 95% CI, 0.75 to 13.06; 7.9% vs 2.7%, respectively; p = 0.065). If the performance of more than two thoracenteses was not considered to be a significant previous pleural intervention, higher rates of failed insertions were seen in the pretreated group (11.4% vs 2.8%, respectively; p = 0.037).

Survival

The overall median survival time following TPC insertion was 144 days (95% CI, 116 to 172 days). Breast cancer patients had a longer median survival time (218 days; 95% CI, 132 to 303 days) than patients with non-small cell lung cancer (108 days; 95% CI, 60 to 155 days) and patients with ovarian cancer (95 days; 95% CI, 41 to 149 days), who had the lowest survival time overall. Mesothelioma patients had a median survival time of 203 days (95% CI, 162 to 244 days), which was significantly higher than that of ovarian cancer patients but was not statistically different than that of lung or breast cancer patients. The 30-day and 1-year mortality rates were 12.8% and 83.6%, respectively. Survival time was significantly longer in patients who experienced SP (254 days; 95% CI, 177 to 331 days) than in those who did not (71 days; 95% CI, 54 to 88 days).

Discussion

The development of MPE is an event that is associated with short life expectancy and significant morbidity. The options for palliation of this condition have previously included repeated therapeutic tho-

### Table 2—Frequency of Complications Post-TPC Placement

<table>
<thead>
<tr>
<th>Complication</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsuccessful insertion</td>
<td>10</td>
<td>4.0</td>
</tr>
<tr>
<td>Symptomatic loculation</td>
<td>21</td>
<td>8.4</td>
</tr>
<tr>
<td>Asymptomatic loculation</td>
<td>10</td>
<td>4.0</td>
</tr>
<tr>
<td>Empyema</td>
<td>8</td>
<td>3.2</td>
</tr>
<tr>
<td>PTX/SQ Air/BPF</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Recurrent fluid</td>
<td>4</td>
<td>1.6</td>
</tr>
<tr>
<td>Dislodged</td>
<td>3</td>
<td>1.2</td>
</tr>
<tr>
<td>Bleeding</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Tumor seeding</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Pain requiring removal</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Extrapleural catheter</td>
<td>1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

*PTX = pneumothorax; SQ = subcutaneous; BPF = bronchopleural fistula.*
racentesis, chest tube drainage followed by instillation of a sclerosing agent into the pleural space, and thoracoscopy.

The performance of repeated thoracentesis procedures is rarely the optimal approach for palliative care in patients with MPE. By definition, procedures are symptom-prompted, making the lasting control of dyspnea incompatible with this approach. The relief of symptoms is usually short-lived, and procedures require repeated visits to emergency departments, offices, or radiology suites often on a semi-urgent basis, placing strain on the patient, the physician, and the health-care system. Thoracentesis should, therefore, be offered as a therapeutic option only for patients in whom survival is expected to be very short or in the occasional patient with a very slowly reaccumulating MPE.

Pleurodesis can be performed with the instillation of a chemical agent through a standard chest drain or via thoracoscopy, and when talc, in particular, is used, pleurodesis has been reported to have high success rates. On the other hand, concerns over the variability in talc preparations and reports of severe acute complications with intrapleural talc administration have led to decreased enthusiasm about its use. Chest tube pleurodesis is associated with an approximately 1-week hospitalization, which is costly and undesirable in patients whose life expectancy is being measured only in weeks. Thoracoscopy requires the use of an operating theater or properly equipped procedure room, anesthesiology staff to administer sedation or general anesthesia, as well as hospital admission leading to significant procedure-related costs. Most importantly, a substantial number of patients with advanced malignancy and short life expectancy are too debilitated to undergo either chest tube pleurodesis or thoracoscopy, and neither of these techniques are applicable to patients with trapped lung, which accounts for at least 30% of patients with MPE. As such, many of the published reports on these techniques are not applicable to an unselected population of patients with MPE. Recent prospective data also have suggested much lower success rates following talc slurry and thorascopic talc poudrage than are usually quoted from less rigorous studies.

The use of TPCs in the management of patients with MPE has previously been reported. This approach offers several key benefits over previous approaches, in particular more liberal patient selection including patients with trapped lungs, outpatient placement and management without sedation or general anesthesia, rapid and persistent symptomatic improvement, cost-effectiveness, and low complication rates.

Our experience with a large number of TPC procedures for the treatment of MPE adds to the published experience with this new technique and allows more accurate descriptions of outcomes and complication rates. The use of TPCs in a dedicated clinic in a regional cancer center, as well as a prospectively maintained procedure database, allowed the collection of accurate data on patient outcomes and survival, despite the retrospective nature of the study.

The large majority of TPC insertion procedures lead to symptom improvement in these patients, which is the primary goal of treatment for patients in this condition. In fact, 222 of 231 successfully inserted TPCs (96.1%) that could be assessed at 2 weeks were associated with partial or complete improvement in symptoms. We used a rigid definition of complete control to avoid bias. Many patients, in particular those with lung cancer, had other reasons for dyspnea such as COPD, lymphangitic carcinomatosis, and malignant airway obstruction. Unless there was an absence of pleural fluid and complete lung reexpansion at 2 weeks, these patients were labeled as having partial control even if the symptoms may have been attributable to issues other than the MPE. As well, the initial frequency of drainage may have been too conservative for some patients, leading to symptom control that would easily improve with higher drainage frequency and volume, which is one of the reasons for the 2-week follow-up visit. Given that symptom control is rarely reported in studies of other treatment modalities, it remains difficult to compare our results with those obtained with pleurodesis. It has been shown in a randomized study that TPC and doxycycline pleurodesis lead to equivalent symptom control. The fact that no other ipsilateral procedures were required in 90.1% of patients attests to the persistent control of MPE achieved in these patients.

SP was seen following 43.9% of all insertions, which is consistent with published data documenting an aggregate rate of 30.5% in a total of 154 patients described in the four largest studies. We found that SP was more likely to occur in patients with good lung reexpansion at follow-up (ie, the absence of trapped lung). In fact, the SP rate of 57.2% in this subgroup is in the range of pleurodesis rates seen in patients treated with chest tube pleurodesis, including that seen in the talc slurry arm of a recent multicenter trial of pleurodesis. It would appear that patients with pleural apposition achieved with TPC in addition to local inflammatory changes induced by a tumor or the TPC itself can achieve pleurodesis without the administration of a sclerosing agent. The SP achieved following TPC insertion is long-lasting, with a rare need for repeat ipsilateral pleural procedures in 8.7% of SP cases.
Catheters stayed in place for a median time of 56 days. While this is a common criticism of this treatment approach, the TPCs are very well-tolerated by patients and have minimal impact on mobility or activity levels. In addition, chemical pleurodesis could be administered via the TPC in patients who achieve good reexpansion of the lung but continue to have fluid drain after a certain period of time, although this has not been our practice, with only seven patients treated in this fashion in this series.

Complication rates were acceptable and compared quite favorably to those seen with other treatment modalities. No treatment-related deaths were observed. Empyema was likely the most severe complication related to TPC and was seen in 3.2% of cases. This is similar to the rates of 2.5% and 4% reported in the two largest case series of patients undergoing thoracoscopic talc poudrage, although a recent multicenter trial documented a rate of only 0.4%. For the most part, patients were treated in the hospital with IV antibiotics and continuous pleural drainage via the TPC, with thrombolysis and additional chest drains used as needed for loculated collections of fluid. Symptomatic loculation of fluid somewhat analogous to “partial pleurodesis” was the most common complication seen in 8.4% of cases. According to the size, location, and degree of septation, management options included thoracentesis, repeat TPC, chest tube insertion, therapy with thrombolytic agents, or observation alone, but the number of cases did not allow for a meaningful assessment of these management strategies.

We think that these complications are acceptable given the additional complications seen in a recent multicenter trial of pleurodesis via talc slurry vs thoracoscopy. This landmark trial demonstrating the equivalence of talc slurry vs thoracoscopic poudrage also documented the significant occurrence of fever, atelectasis requiring two or more bronchoscopies, pneumonia, respiratory failure, dysrhythmia requiring treatment, and treatment-related deaths associated with these techniques. These data suggest that the primum non nocere argument directed toward the use of TPCs should rather be directed toward the current standard treatment modalities.

An overall median survival time for our patients of 20 weeks, with 30-day and 1-year mortality rates of 12.8% and 83.6%, respectively, reinforces our belief that palliative treatment approaches for MPE should be as simple, uncomplicated, and effective as possible. A “short” 1-week stay in the hospital for these patients represents 5% of their remaining life span, which likely would be better spent outside our hospitals and with their friends and families. Our 30-day mortality rate was lower than that seen in both arms of a recent trial (17% aggregate, excluding patients with trapped lungs) despite the presence of an unselected group of what we believe to be a more debilitated population. As such, it does not appear that our less aggressive approach leads to compromised survival.

Costs were not measured in this study. The use of TPCs leads to new expenses such as catheter-draining supplies and home care support. Avoiding the need for the use of hospital inpatient and operating room resources certainly leads to a cost benefit in the short term, but no long-term economic analysis comparing the use of TPCs and other modalities has been performed.

To our knowledge, this case series represents the largest group of patients who have been treated with TPC to date. Our large experience in the application of TPCs in patients with MPEs in a clinical setting confirms that long-term palliation can be achieved in a large proportion of relatively unselected patients on an outpatient basis and with acceptable complication rates. The use of TPCs should be considered as a first-line treatment option for symptomatic MPEs. Further studies randomizing patients to treatment with a TPC vs talc slurry or thoracoscopy, including an economic analysis, would be of benefit.

References
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