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# Is pain catastrophizing scale useful for predicting post-thoracotomy pain after lung cancer surgery?

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**Background:** The aim of this study was to evaluate preoperative pain catastrophizing scale (PCS) for predicting post-thoracotomy pain in patients with non-small-cell lung cancer.
**Methods:** We previously conducted a randomized open control trial that was published under the title "Is early postoperative administration of pregabalin beneficial for patients with lung cancer?" This is a report of analysis of that trial's secondary endpoint using PCS. PCS were obtained before surgery, on 1 and 7 days and at 1 and 3 months after surgery.
**Results:** The study cohort comprised 67 patients. Postoperative pain scored on a numeric rating scale (NRS) was significantly less 3 months after surgery (p<0.001). Total PCS and all three subcategory scores were significantly less 3 months after surgery (p<0.001). The cohort was divided into a low PCS score (≦25) group of 32 and a high (>25) PCS score group of 35 according to the median preoperative PCS score. None of the assessed patient characteristics, including age, sex, body mass index, type of surgical procedure and lymph node dissection, operation time, bleeding, duration of chest tube insertion, and consumption of analgesia differed significant between these groups. The NRS scores on postoperative day 1 (p=0.33), day 7 (p=0.50), 1 month (p=0.31) and 3 months (p=0.18) did not differ significantly between the groups. Multiple logistic regression analyses was performed to predict the postoperative significant pain intensity (NRS≧3) at any postoperative period found that preoperative PCS was not the significant factor.
**Conclusions:** PCS scores did not predict acute or chronic postoperative thoracotomy pain.

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**Key words:** pain catastrophizing scale, post-thoracotomy pain, non-small-cell lung cancer

## Introduction

In Japan, as in many developed countries, lung cancer is still the leading cause of cancer deaths. The number of surgeries for non-small cell lung cancer (NSCLC) is increasing [1]. Minimally invasive surgery, including video-assisted thoracic surgery (VATS) and segmentectomy for small peripheral non-solid NSCLC, is performed widely throughout the world. However, post-thoracotomy pain is still an issue for some patients.

Post-thoracotomy pain syndrome (PTPS) has been defined by the International Association for Study of Pain as "Pain that recurs or persists along a thoracotomy scar for at least 2 months following a surgical procedure" [2]. Uncontrolled PTPS can lead to reduced physical function and quality of life as well as increased healthcare costs [3]. It has been reported that the incidence of chronic postoperative pain is greater after thoracotomy (6%–65%) than after cardiac surgery (30%–55%), mastectomy (20%–50%), hip replacement (12%), and Caesarean section (6%), respectively [4].

Many approaches to reducing the incidence of PTPS have been attempted [5–11]; these approaches include surgical approach (performed by VATS), anaesthetic technique (epidural, paravertebral and intercostal block), and various medications, including nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, ketamine, gabapentin, and pregablin. VATS seems to be the best approach to reducing the incidence of PTPS because it minimizes intercostal nerve damage [5]. Nevertheless, even after minimally invasive procedures, some patients still develop PTPS. Moreover, there is little clinical evidence regarding prevention of PTPS. Thus, PTPS remains a problem for patients even in the era of less-invasive surgery.

Cognitive and psychological factors reportedly have important roles in determining the severity of postoperative pain. Extreme pain catastrophizing (a type of negative and distorted thinking) is associated with heightened experience of pain and appears to contribute to the development of chronic pain [4, 12]. The effects of pain catastrophizing have been reported for various types of surgery, including total knee arthroplasty and spine, breast cancer, and cardiac surgery [2, 12–16]. In addition, 16 of 29 meta-analyses (55%) have reported statistically significant associations between anxiety or pain catastrophizing and chronic postoperative pain [17]. If pain catastrophizing can predict the intensity of postoperative pain, consideration could be given to utilizing a variety of resources to ameliorate or prevent such pain. For example, patients who strongly catastrophize pain could be identified early and interventions such as education about the expected clinical course, pain and rehabilitation offered preoperatively, possibly contributing to reducing PTPS. However, to date, there have been no reports about evaluation of pain catastrophizing in patients undergoing lung cancer surgery.

The purpose of this study was to determine whether pain catastrophizing can predict the intensity of acute or chronic post-thoracotomy pain in patients with NSCLC.

## Patients and methods

### Study design

This study is an analysis of the secondary endpoint of a previously conducted randomized control trial undertaken at Nagasaki University Hospital (Nagasaki, Japan) from January 2014 to December 2015. This study was registered with the Clinical Trial Registry of the University Hospital Medical Information Network (UMIN 000012386). Approval was also obtained from the local Ethics Committee before the study commenced (Approval number: 13093038). All patients provided written informed consent before enrolment. The details of this study have already been described [7]. Briefly, consecutive patients aged 45–75 years scheduled for pulmonary resections for primary NSCLC were randomized to receive early postoperative pregabalin or not. Additionally, an epidural catheter was placed according to the site of incision before induction of general anesthesia for postoperative pain relief.

In the original trial, the primary endpoint was not achieved in that the requirement for an additional suppository of 25 mg diclofenac sodium was lower in the pregabalin group; moreover, there was no evidence that pregabalin conferred a significant benefit. That study also had several secondary endpoints, namely intensity of ongoing pain, frequency of neuropathic pain, and catastrophizing scale (PCS) scores. This is a detailed report concerning one of those secondary endpoints, the PCS.

### Measures

The following patient characteristics were recorded: patient-related (sex, age, body mass index, operation history [general anesthesia, excluding local anesthesia]); surgery-related (type of pulmonary resection [lobectomy/limited; segmentectomy and wedge resection]; type of thoracotomy [open; using metal retractors/VATS], type of lymph node dissection [radical: node dissection [ND]2; limited: ND0–1], operation time, bleeding, duration of chest-tube insertion, postoperative stay (day); and analgesia-related (amount of additional NSAIDs required, use of pregabalin). These data had already been collected in the original study.

### Ongoing pain and pain catastrophizing

Intensity of ongoing pain was quantitated by using a numeric rating scale (NRS; 0: no pain; 10: worst possible pain). NRS scores were obtained three times a day by nurses who were blinded to the study protocol. The worst NRS score during each day was used in the present study. We defined significant postoperative pain intensity as NRS≧3, which value was adopted by previous report [13], and by our results that median value of NRS at POD1 was 3.

Pain catastrophizing was evaluated using a PCS, a screening tool for pain catastrophizing devised by Sullivan and colleagues [18]. Catastrophizing, a type of negative and distorted thinking, can be defined as "an exaggerated negative 'mental set' brought to bear during actual or anticipated painful experi-

ences" [19]. The characteristics of PCS are shown in Table 1. The PCS is a 13-item questionnaire with three components: rumination (e.g., "I can't stop thinking about how much it hurts"), magnification: (e.g., "I'm afraid that something serious will happen"), and helplessness: (e.g., "There's nothing I can do to reduce the intensity of the pain"). Each item is rated on a five-point scale from 0 = "not at all" to 4 = "all the time". Scores range from 0 ("no catastrophizing") to 52 ("severe catastrophizing") with no clear cut-off between "high" and "low" catastrophizing scores [19]. This questionnaire has been translated into Japanese and its validity and reliability evaluated by Matsuoka and workers [20].

**Table 1**. Pain catastrophizing scale

| |
| --- |
| Helplessness (6) |
|  It is terrible and I think it is never going to get any better |
|  It is awful and I feel that it overhelms me |
|  I worry all the time about whether the pain will end |
|  I feel I cannot stand it anymore |
|  I feel I cannot go on |
|  There is nothing I can do to reduce the intensity of the pain |
| |
| Rumination (4) |
|  I anxiously want the pain to go away |
|  I cannot seem to keep it out of my mind |
|  I keep thinking about how much it hurts |
|  I keep thinking about how badly I want the pain to stop |
| |
| Magnification (3) |
|  I become afraid that the pain will get worse |
|  I keep thinking of other painful events |
|  I wonder whether something serious may happen |

*Follow-up*

NRS pain scores were obtained at every day following surgery and 1 and 3 months after surgery. PCS was scored before surgery, on POD7, and 1 and 3 months after surgery. Patients visited outpatient clinics 1 and 3 months after surgery; if they did not keep these appointments, a questionnaire was posted to their homes.

*Statistical analyses*

Data are presented as frequencies for categorical variables and as the median and range for quantitative variables. Associations between variables were assessed with Fisher's exact test for categorical variables and the Mann–Whitney U

test for quantitative variables. Multiple logistic regression analyses were performed for predicting postoperative significant pain intensity (NRS≥3) with odds ratio and 95% confidence interval. These analyses included preoperative PCS, age, gender, BMI, VATS, operation time, and operation history. A p value of 0.05 or less (two-sided) was considered to indicate statistical significance. JMP v13 (SAS Institute, Cary, NC, USA) was used for statistical analyses.

## Results

In all, 220 patients underwent surgery for NSCLC from December 2013 to December 2015. After applying exclusion and inclusion criteria, 67 patients completed the study and were assessed. Of these 67 patients, 32 patients were in the low PCS (≦25) and 35 in the high (>26) PCS score group according to the median value of PCS (median 3 on POD1; range: 0–46; mean value: 24.4).

Table 2 shows the patients' characteristics. Of the patient-related factors, sex (p=0.51), age (p=0.69), BMI (p=0.96), and operation history (p=0.73) did not differ significantly between the low PCS and high PCS score groups. None of the surgery-related factors differed significantly between the low PCS and high PCS score groups: type of pulmonary resection (lobectomy/segmentectomy or wedge resection, p=0.13), type of lymph node dissection (ND2/ND0–1, p=0.57), approach (VATS/thoracotomy; p=0.41), operation time (p=0.74), bleeding (p=0.20), and duration of chest-tube insertion (p=0.09). Neither of the analgesia-related factors differed significantly between the low PCS and high PCS score groups: additional NSAIDs (a 25 mg suppository of diclofenac sodium) (p=0.99), and use of pregabalin (150 mg daily) (p=0.91). Thus, no patient characteristics differed significantly between the low and high PCS score groups.

*Intensity of ongoing pain*

Figure 1 showed changes in intensity of ongoing pain in all patients. NRS scores gradually decreased with time postoperatively, and NRS scores 3 months after surgery were significantly lower than on POD1 (p<0.001).

*Pain catastrophizing scale*

Figure 2 showed changes in total PCS scores and its subscales (rumination, helplessness, and magnification) for all patients. All scores gradually decreased over time. Total PCS scores 3 months after surgery were significantly lower than

before surgery (p<0.001), as were the scores for all subscales (p<0.001). By dividing into low PCS group and high PCS score group, Similar results, such as, low and high PCS scores 3 months after surgery were significantly lower than before surgery (p<0.01), as were the scores for all subscales (p<0.01).

*Correlation between PCS scores and intensity of ongoing pain*

Figure 3 showed the transition of the intensity of ongoing pain according to PCS score group. NRS scores on POD1 (p= 0.33), POD7 (p=0.49), and at 1 (p=0.31) and 3 months (p=0.18) after surgery did not differ significantly between the groups.

**Table 2.** Patients' characteristics according to pain catastrophizing scale scores

|  |  |  | Low PCS ( ≦ 25) | High PCS (>26) | p value |
|---|---|---|---|---|---|
|  | Number |  | 32 | 35 |  |
| Patient-related | Sex | Male / Female | 19 / 13 | 18 / 17 | 0.51 |
|  | Age | Median (year, range) | 67 (51–75) | 69 (45-75) | 0.69 |
|  | BMI | Median (kg/m$^2$, range) | 22.7 (15.1–34.5) | 22.3 (16.4–30.5) | 0.96 |
|  | Operation history | Yes / No | 16 / 16 | 16 / 19 | 0.73 |
| Surgery-related | Procedure | Lobectomy / Limited | 27 / 5 | 32 / 3 | 0.13 |
|  |  | ND2 / ND0-1 | 29 / 3 | 33 / 2 | 0.57 |
|  | Approach | VATS / Thoracotomy | 16 / 16 | 21 / 14 | 0.41 |
|  | Operation time | Median (minute, range) | 225 (145–398) | 218 (126–388) | 0.74 |
|  | Operative bleeding | Median (mL, range) | 115 (20–1260) | 90 (10–550) | 0.20 |
|  | Chest tube insertion | Median (days, range) | 4 (2–15) | 3 (2–9) | 0.09 |
|  | Postoperative stay | Median (days, range) | 11 (8-26) | 11 (8-17) | 0.78 |
| Analgesia-related | Additional NSAIDs | Median (mg, range) | 50 (0–375) | 50 (0–300) | 0.99 |
|  | Pregabalin 150mg/day | Yes / No | 16 / 16 | 17 / 18 | 0.91 |

PCS: Pain catastrophizing scale
BMI: Body mass index
Limited: Limited resection (segmentectomy or wedge resection)
ND: Node dissection
VATS: Video-assisted thoracic surgery
NSAIDs: Non-steroid anti-inflammatory drugs

**Table 3.** Multiple logistic regression analyses of possible predictors of postoperative pain intensity (numeric rating scale score ≧ 3)

|  | POD1 | POD7 | 1M | 3M |
|---|---|---|---|---|
| Variables (reference) | Odds ratio (95% CI), p value | | | |
| Preoperative PCS | 0.98 (0.93-1.03), p= 0.37 | 1.01 (0.96-1.07), p= 0.62 | 1.04 (0.99-1.10), p= 0.08 | 1.01 (0.95-1.07), p =0.84 |
| Age | 0.97 (0.87-1.08), p= 0.57 | 0.91 (0.81-1.01), p= 0.07 | 0.99 (0.89-1.09), p= 0.79 | 1.06 (0.91-1.26), p= 0.48 |
| Sex (male) | 0.88 (0.27-2.88), p= 0.84 | 1.30 (0.38-4.44), p= 0.68 | 0.86 (0.27-2.70), p= 0.80 | 0.83 (0.18-3.91), p= 0.82 |
| BMI | 1.03 (0.93-1.14), p= 0.60 | 0.99 (0.91-1.11), p= 0.89 | 1.06 (0.94-1.19), p= 0.34 | 0.88 (0.69-1.10), p= 0.27 |
| VATS (yes) | 2.88 (0.87-9.45), p= 0.08 | 0.61 (0.18-2.13), p= 0.44 | 1.43 (0.45-4.51), p= 0.54 | 2.48 (0.41-14.9), p= 0.32 |
| Operation time | 1.00 (0.99-1.01), p= 0.65 | 1.00 (0.99-1.01), p= 0.32 | 1.01 (0.99-1.02), p= 0.21 | 1.01 (0.99-1.02), p= 0.14 |
| Operation history (yes) | 0.31 (0.10-1.00), p= 0.05 | 0.92 (0.27-3.16), p= 0.89 | 0.75 (0.24-2.36), p= 0.63 | 0.55 (0.11-2.67), p= 0.46 |

POD: Postoperative day
CI: Confidence interval
PCS: Pain catastrophizing scale
BMI: Body mass index
VATS: Video-assisted thoracic surgery

*Multiple logistic regression analysis*

Multiple regression analyses of factors including age, sex, BMI, VATS, operation time, and operation history versus significant postoperative pain intensity (NRS≥3) was performed at the specified times. No significant associations were identified, and these results were shown in Table 3.
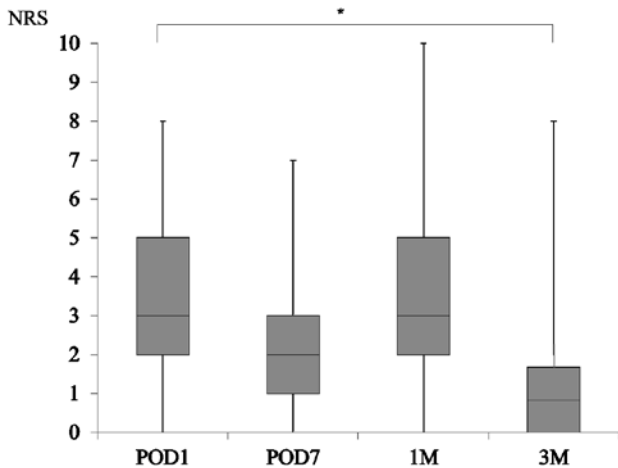


**Figure 1.** Postoperative pain scores on a numeric rating scale (NRS). NRS scores at 3 months were significantly lower than on POD1 (p<0.001). NRS; Numeric rating scale. POD; postoperative day; M; postoperative month. Horizontal bars denote standard deviation. *; statistically significant
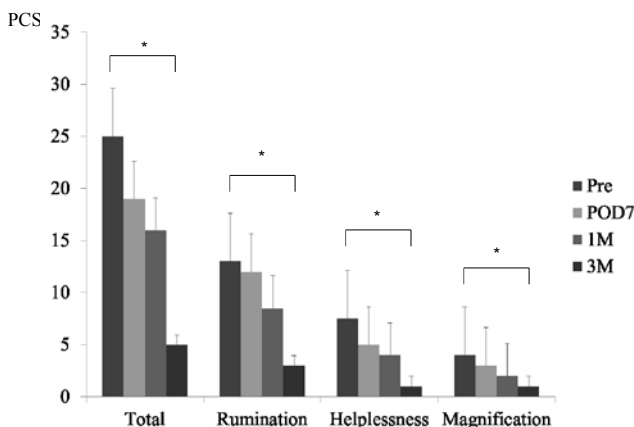


**Figure 2.** Changes in pain catastrophizing scale scores overall and for each subcategory. PCS scores at 3 months were significantly lower than on preoperative day (p<0.001) overall and for all subcategories. PCS: Pain catastrophizing scale, Pre; preoperative day, POD; postoperative day; M; postoperative month, Horizontal bars denote standard deviation. *; statistically significant
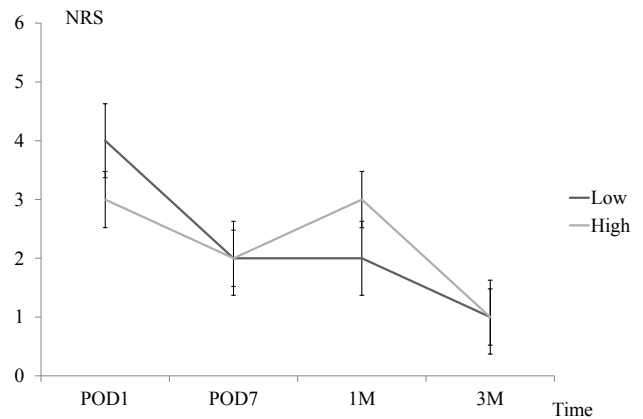


**Figure 3.** Postoperative pain according to numeric rating scale (NRS) scores according to pain catastrophizing scale score groups (PCS, Low ≦ 25, high>26). No significant differences were identified for any observed time point. Pre; preoperative day, POD; postoperative day; M; postoperative month, Horizontal bars denote standard deviations.

## Discussion

In this study of data from 67 patients who underwent pulmonary resection for NSCLC, we found no association between the strength of pain catastrophizing and intensity of acute and chronic (3 months) postoperative pain after lung cancer surgery.

Post-thoracotomy pain is well established as a clinically important entity that has remained an issue for patients even since the wide-spread adoption of less invasive surgical procedures like VATS or uni-portal surgery. Uncontrolled perioperative pain is problematic; for example, impairment of coughing can result in retention of airway secretions, which can lead to atelectasis and pneumonia requiring longer hospital stays and more medical costs. Chronic PTPS is reportedly associated with significantly decreased physical function, mental deterioration and impaired quality of life [3]. However, to date, no evidence-based treatment or means of preventing PTPS have been clearly identified although many types of intervention have been attempted. To date, one of the best established predictors of chronic postoperative pain is the severity of acute pain after surgery [21]. Our previous randomized control trial, which aimed to reduce the severity of acute postoperative pain by early administration of pregabalin, found this measure to be ineffective in reducing requirements for additional doses of NSAIDs.

Psychological variables such as pain catastrophizing, anxiety, and depression also have proven relevance in prediction of persistent postoperative pain [13]. This prompted us to

explore former studies investigating pain catastrophizing and to study the relationships between intensity of pain and psychological factors using the PCS in patients undergoing lung cancer surgery.

We found that both total PCS and all PCS subscale scores gradually decreased postoperatively, indicating that pain catastrophizing improved in parallel with reduction in intensity of ongoing pain. Exceptionally, at 1 month after surgery, NRS was re-increased in high PCS group. We speculated that pain might have increased as a result of increased home activity after leaving the hospital compared to during hospitalization with POD7. Several studies have reported an association between preoperative pain catastrophizing and postoperative pain intensity for many types of surgery. Dunn et al. reported that patients with higher PCS scores were more likely to have higher maximum pain scores postoperatively after adult spine surgery. In addition, patients with higher preoperative depression scores evaluated by the Hospital Anxiety and Depression Scale had a lower quality of recovery after surgery [15]. Moreover, Bierke et al. reported an association between preoperative PCS scores and pain 6 and 12 months postoperatively [16]. They reported that pain catastrophizing was useful in predicting pain in both the acute and chronic phase. In the thoracic field, 25% of 104 young male patients undergoing surgery for pectus excavatum still reported clinically relevant pain (NRS score≥3) 3 months after surgery and pain anxiety and pain hypervigilance were significant predictors of persistent postoperative pain [13]. Weissman-Fogel et al. reported that presurgical pain temporal summation responses predict post-thoracotomy pain intensity during the acute postoperative phase [22]. In their study, patients underwent several psychophysical tests before thoracotomy, including responses to heat pain, mechanical pain (pinprick), and questionnaires about personality that incorporated anxiety and pain catastrophizing. They found that enhanced temporal summation and higher pain scores for mechanical stimulation were significantly associated with greater provoked (when coughing) postoperative pain intensity. These findings suggest that identification and reduction of psychological factors may help to optimize pain management after thoracic surgery. For example, preoperative identification of patients with high pain catastrophizing scores could enable provision of educational tools such as a video regarding the expected clinical course of this surgery, pain and rehabilitation, thus likely contributing to reducing postoperative pain.

In contrast, there are also several reports of negative results. Wright et al. evaluated 87 patients undergoing total joint arthroplasty [23]. In their study, patients were divided into catastrophizers (PCS score >30) and non-catastrophizers (PCS score ≤ 30) and visual analog scale (VAS) pain scores evaluated at the 3-month follow-up. There was no clinically significant difference in VAS pain scores between the groups; however, VAS pain scores may be a risk factor for increased length of hospital stay. In addition, Khan et al. reviewed pain catastrophizing and its association with postoperative pain and quality of life [4]. They reported findings no consensus on the relationship between pain catastrophizing and analgesic consumption. These results are in part compatible with our results in that we identified no significant relationships between intensity of ongoing pain and pain catastrophizing. It would therefore be difficult for clinicians to reduce PTPS by using PCS scores. We speculated that patients with a history of surgery have a belief about their clinical course and this would partially predict postoperative pain; however, this result was identified. Surprisingly, we did not identify VATS as significant for both acute and chronic phases.

There are several possible explanations for our failure to identify any predictors of PTPS. First, as has repeatedly been reported [5–7], the problem is that there are no objective tools for assessing pain. The NRS is a subjective, not an objective, assessment tool, and pain perception is difficult to interpret. Moreover, pain expression may be affected by ethnicity, sex, age, and other factors. Thus, we cannot evaluate pain objectively. Second, NRS scores were relatively low during the observed periods. Against our expectations, only 10 patients (15.0%) reported NRS pain scores ≥3 at 3 months after surgery. We speculate that our daily regimen for pain management (epidural analgesia and NSAIDs) may be effective, preventing identification of a significant difference between the two groups. Third, the efficacy and appropriate cut-off value of PCS scores for thoracic surgery have not been established. We allocated patients to groups according to their median PCS scores, whereas other researchers have used a PCS score of 30 as a cut-off [23]. The use of receiver operating characteristic curves may be preferable. In addition, there are many tools for evaluation of psychological factors and we do not know which of them is the best useful for patients undergoing surgery. Last, we still believe that psychological factors are importance regarding perioperative pain; however, the mechanisms of PTPS seem to be more complicated than postoperative pain after other surgeries. On the basis of our serial studies about PTPS [5–7], we recommend that we should address prevention of PTPS from many perspectives, including VATS, anaesthetic techniques, new medications, and psychological factors (Fig. 4).

The present study has three main limitations. First, the study cohort was small and obtained from a single institution.

Second, patients undergoing VATS and thoracotomy were included in both groups, thereby hampering evaluation. It would have been preferable to study only patients undergoing VATS or thoracotomy. These limitations have been acknowledged in a previous report [7]. Lastly, since the significant cut-off value of PCS was still ambiguous and not based on evidence, median value of PCS was adopted in this study. Future studies and useful tools for evaluating psychological factors are needed to address these limitations and to evaluate associations between PCS scores and PTPS after lung cancer surgery.

In conclusion, we here report the clinical effect of pain catastrophizing on post-lung cancer surgery pain. PCS scores did not predict the intensity of postoperative thoracotomy pain. Further studies including objective tools for evaluation of postoperative pain are required to reduce the incidence and severity of PTPS.
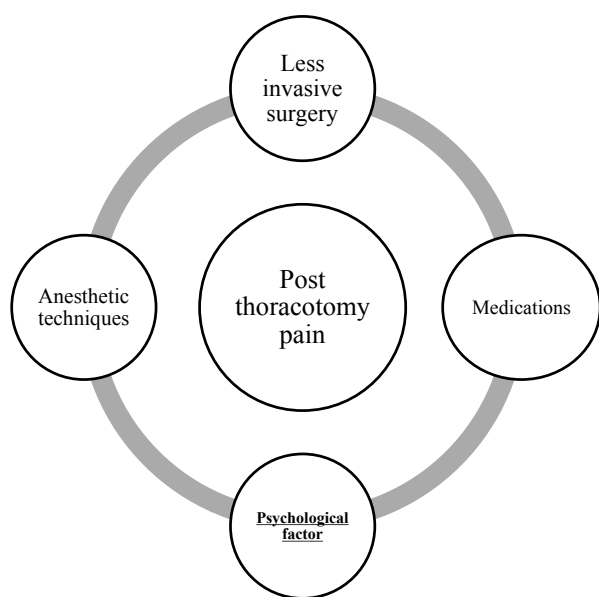


**Figure 4.** Diagrammatic representation of strategies for preventing post thoracotomy pain

## Acknowledgements

Conflict of interest

None declared.

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