Polish Annals of Medicine

Journal homepage: https://www.paom.pl

Case Report

Intraoperative cryoanalgesia in pleural drainage procedures during video-assisted thoracoscopy – a case report

Michał Szostawicki, Robert Marguła

Department of Surgery, Clinical Department of Pediatric Surgery and Urology School of Public Health, Collegium Medicum, University of Warmia and Mazury in Olsztyn, Poland

Article info

Article history
Received: February 12, 2025
Accepted: March 31, 2025
Available online: June 4, 2025

Keywords
pneumonia
case report
video-assisted thoracoscopy
cryoanalgesia
pleural drainage

Doi
https://doi.org/10.29089/paom/203570

Abstract

Introduction: The gold standard for the surgical treatment of pleural effusion is pleural drainage using video-assisted thoracoscopy (VATS). Intraoperative intercostal nerve cryoanalgesia may be a solution to reduce both the supply of analgesics, including opioids, and hospitalisation time.

Aim: The aim of the study was to describe the use of cryoanalgesia for better pain control during pleural drainage in the course of pneumonia complicated by pleural effusion.

Case study: A 6-year-old male patient was admitted to the Department of Paediatric Surgery for treatment of pleural empyema in the course of pneumonia. After no regression of the pleural lesions, the patient was qualified for surgical treatment. Pleural drainage uduring VATS and intraoperative intercostal nerve cryoanalgesia was performed. The mean numerous rating scale of pain (NRS) score during the first 5 days after drain insertion was 4, 4, 3, 3, 2 points. The only pharmacological drug used in postoperative pain treatment was paracetamol and, on day 1, Nalbuphine. The patient was discharged from hospital after 1 week. No complications after the procedure were noted.

Results and discussion: The standard treatment for pneumonia complicated by effusion is a prolonged course of intravenous antibiotic therapy as a first-line treatment, but most patients can be treated with pleural drainage using VATS to remove the fibrin surrounding the lung. Intraoperative intercostal nerve cryoanalgesia can support analgesic treatment during pleural drainage and also reduces the number of adverse reactions occurring when opioids are used.

Conclusions: Intraoperative intercostal nerve cryoanalgesia is a safe method for patients requiring pleural drainage during the VATS procedure. Performing VATS-guided pleural drainage is a safe and effective method for treating pleural empyema.

Corresponding author: Michał Szostawicki; Department of Surgery, Clinical Department of Pediatric Surgery and Urology School of Public Health, Collegium Medicum, University of Warmia and Mazury in Olsztyn Żołnierska 18a, 10-561 Olsztyn, Poland. Tel.: +48 660 721 759.
E-mail address: mszostawicki@wp.pl

1. INTRODUCTION

The use of low temperatures to reduce pain has been known and developed for centuries. The breakthrough was a method described in 1963 by Cooper, who used a cryoprobe with liquid nitrogen at –196°C, targeting the peripheral nerves. Cryoanalgesia is currently widely used in many areas of medicine, including cardiothoracic surgery and orthopaedics.[1] The clinical case described refers to the application of intraoperative cryoanalgesia in the pleural drainage procedure during video-assisted thoracoscopic surgery (VATS) in the treatment of pneumonia complicated by pleural effusion. Pleural effusion is the liquid content found in the pleural space, usually associated with a severe course of pneumonia.[15] The disease is diagnosed in 20 to 40 cases per 1000 children per year, mainly due to pneumococcal infection.[2] More than 50% of children hospitalised for pneumonia are complicated by pleural effusion.[5] Numerous treatment options are available, including antibiotic therapy, fibrinolytic drugs, and surgical treatment, where the gold standard is pleural drainage, and VATS is also used. Complications following the VATS procedure are rare and occur in 3%–4% of cases, with the most common being bleeding, infections and postoperative pain.[14] Pain management after VATS usually includes systematically administered analgesics, such as acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs), as well as opioids, with thoracic epidural analgesia being less common.[16] The use of opioids is linked to possible complications, including nausea, vomiting, prolonged hospitalisation, opioid dependence andrespiratory depression.[16] Intraoperative intercostal nerve cryoanalgesia, performed during pleural drainage and VATS, may be a solution to reduce both the supply of opioids and hospitalisation time. The cryoanalgesia mechanism is based on a model in which administering a low temperature through a cryoprobe acts as a trigger to set off pathophysiological events. It blocks the transmission of pain through the peripheral nerves in a reversible manner and after a period of time determined by the parameters set in the cryoprobe.[3]

2. AIM

The aim of the study was to describe the therapeutic options for pneumonia complicated by pleural effusion and the possible uses of cryoanalgesia to reduce opioid use during pleural drainage.

3. CASE STUDY

TA, a 6-year-old male patient, was admitted to the Department of Paediatric Surgery for treatment of pleural empyema in the course of pneumonia (pleuropneumonia). The patient complained of fever, cough, and chest pain on the left side while coughing. A physical examination showed a normal alveolar murmur and fine-bubble rales at the base of

Figure 1. RTG at admission.

Figure 2. Follow-up USG at day 3.

Figure 3. Follow-up USG at day 6.

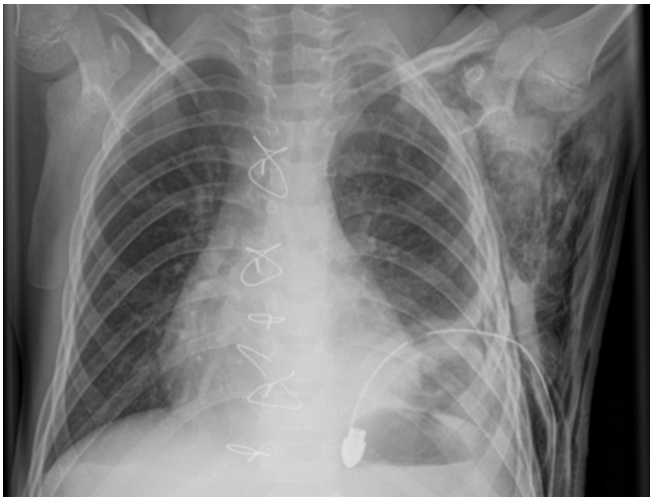

Figure 4. Post-surgery RTG.

Figure 5. Intraoperative cryolesion of 5th right intercostal nerve.

the left lung. The patient has trisomy 21 and has undergone correction of the atrioventricular septal defect (AVSD). The abnormalities revealed in laboratory testing include leukocytosis and elevated C-reactive protein (CRP) levels. X-ray examination (Figure 1) showed complete shadowing of the left lower lung field, with a blurred left costophrenic angle and the outline of the left diaphragmatic dome. A diagnosis of pneumonia was made, and antibiotic therapy with ceftriaxone and clindamycin was commenced. After 3 days, a follow-up thoracic ultrasound was performed (Figure 2) to reveal the pleural space fluid to be increased to 2 cm. Azithromycin was added to the treatment. After 3 days, another follow-up ultrasound was performed (Figure 3), which showed fluid at the base of the left lung with echogenic bands reflecting the fibrin band. Due to the progression of the disease, the patient was qualified for surgical treatment of pleural empyema. Usingmini-thoracotomy, the pleura was cleared under thoracoscopic guidance, and the pleural drain was inserted in the left anterior axillary line through an incision in the 5th intercostal space at the level of the left lung base (Figure 4). This was followed by intraoperative intercostal nerve cryoanalgesia, with a cryoprobe inserted through the same incision to freeze the left 5th intercostal nerve (Figure 5). After the procedure, antibiotic therapy and intravenous hydration were provided to the patient. On the day after the procedure, the patient felt well, had an appetite and no fever. Four days after the procedure, after collecting 150 mL of the fluid from the pleural space, the drain was removed, and the patient was transferred to the paediatric ward for further pharmacological treatment. The mean numerous rating scale (NRS) of pain score during the first 5 days after drain insertion was 4, 4, 3, 3, 2. The only pharmacological drug used in postoperative pain treatment was acetaminophen, except on day 1 after the procedure, when the opioid Nalbuphine was used. After 1 week, the patient was discharged from hospital in good general condition (Figure 6). No early or distant complications related to VATS, pleural drainage or cryoanalgesia were noted.

4. RESULTS AND DISCUSSION

The occurrence of pleural effusion in the course of pneumonia is a serious life-threatening condition. If not treated optimally, pleural effusion can lead to systemic infection, sepsis and respiratory distress, requiring aggressive antibiotic treatment and, in severe cases, drainage procedures such as thoracocentesis, pleural drainage, or even thoracotomy.[9] Since the gold standard for the treatment of pleural effusion is a debatable topic, there is a need for further research into the development of optimal treatment. An important therapeutic component of pneumonia complicated by pleural effusion is observation and imaging examinations used to assess regression or progression, bearing in mind that complicated pneumonia should be suspected in patients who do not respond to adequate antibiotic treatment after 48–72 h.[6] The standard treatment for pneumonia complicated by effusion, described by Laure Menestrino Prestes et

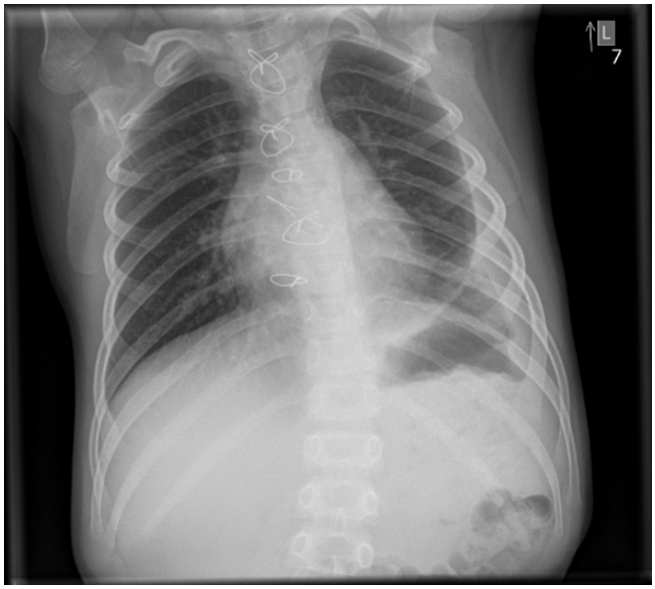

Figure 6. RTG before end of hospitalization.

al. is a prolonged course of intravenous antibiotic therapy as a first-line treatment, but most patients can be treated with pleural drainage using VATS.[6] When compared to surgical treatment, it is worth noting that VATS procedures, as opposed to open thoracotomy, are associated with shorter hospitalisation, less need for analgesics, and shorter time required to remove drains from the thorax.[7] Nevertheless, VATS, like other surgeries, are procedures that require the use of analgesics and opioids while also resulting in possible iatrogenic pharmacological complications.

Postoperative pain following thoracic surgery affects the quality of life, the number of pulmonary complications, and the recovery time.[4] The application of intraoperative intercostal nerve cryoanalgesia can support analgesic treatment following pleural drainage during VATS. Cryoanalgesia has gained popularity in treating pectus excavatum usingthe Nuss method, where intraoperative cryoanalgesia significantly reduces hospitalisation time and the amount of opioids used.[10,11] The application of cold to tissues to ablate the target nerve causes reversible neuronal damage, which induces a conduction block similar to local anaesthesia. Cryoanalgesia of the nerve causes Wallerian degeneration, which is a reversible breakdown of the nerve axon, whereas axon regeneration, and thus pain sensation, returns after a few weeks.[12] Cryoanalgesia is useful in the treatment of many persistent pain conditions, especially when a specific peripheral nerve can be accurately identified as the source of pain.[12] Pain in patients with pleural drainage may result from continued irritation of the pleura innervated by sensory fibres of the intercostal and phrenic nerves,[13] but this has not been investigated. It is worth considering cryoanalgesia of the nerves that innervate the specific part of the pleura where the drain would be located. The authors suggest conducting a study on a larger population, as the main limitation of the present article is that it is a case report. Nevertheless, it has been noted that the application of cryoanalgesia during the VATS procedure is associated with opioid use being lower than that without cryoanalgesia, which is further associated with lower adverse reactions.[8] As mentioned, in the case described, the mean NRS score during the first five days after drain insertion was 4, 4, 3, 3, 2, resulting in a mean NRS pain score of 3.2. Pain was controlled with paracetamol and Nalbuphine. The authors emphasise the need to consider further research into the use of cryoanalgesia during the pleural drainage procedure as an additional analgesic therapy.

Further research is required to determine the long-term efficacy, safety profile, and potential advantages of cryoanalgesia compared to conventional analgesic methods. The number of reported pediatric cases remains limited, and current follow-up data are difficult to analyze due to the recent introduction of cryoanalgesia in pediatric thoracic surgery. Nevertheless, reports on surgical management of pleural empyema in children emphasize pain control as a critical factor determining treatment outcomes.[17,18]

5. CONCLUSIONS

(1) VATS-guided pleural drainage is a safe and effective treatment for empyema.
(2) Intraoperative intercostal nerve cryoanalgesia is a safe analgesic technique during VATS with pleural drainage.
(3) Cryoanalgesia combined with VATS may reduce opioid consumption.
(4) Reduced opioid use may support improved postoperative pulmonary rehabilitation.

Conflict of interest

None declared.

Funding

None declared.

References

1 Yiu WK, Basco MT, Aruny JE, Cheng SW, Sumpio BE. Cryosurgery: A review. *Int J Angiol*. 2007;16(1):1–6. https://doi.org/10.1055/s-0031-1278235.
2 Brims FJ, Lansley SM, Waterer GW, Lee YC. Empyema thoracis: new insights into an old disease. *Eur Respir Rev*. 2010;19(117):220–228. https://doi.org/10.1183/09059180.00005610.
3 Wunderink RG, Mutlu GM. Pneumonia: Overview and Epidemiology. In: *Encyclopedia of Respiratory Medicine*. London: Elsevier; 2006:402–410. https://doi.org/10.1016/B0-12-370879-6/00308-2.
4 Di Napoli G, Ronzini M, Paradies G. VATS: first step in the parapneumonic empyema. *G Chir*. 2014;35(5–6):146–148.
5 Łochowski MP, Kozak J. Video-assisted thoracic surgery complications. *Wideochir Inne Tech Maloinwazyjne*. 2014;9(4):495–500. https://doi.org/10.5114/wiitm.2014.44250.
6 Spaans LN, Dijkgraaf MGW, Meijer P, et al; OPtriAL study group. Optimal postoperative pain management after VATS lung resection by thoracic epidural analgesia, continuous paravertebral block or single-shot intercostal nerve block (OPtriAL): study protocol of a three-arm multicentre randomised controlled trial. *BMC Surg*. 2022;22(1):330. https://doi.org/10.1186/s12893-022-01765-y.
7 Benyamin R, Trescot AM, Datta S, et al. Opioid complications and side effects. *Pain Physician*. 2008;11(2 Suppl):105–120.
8 Krishna R, Antoine MH, Alahmadi MH, Rudrappa M. Pleural Effusion. 2024. Treasure Island (FL): StatPearls Publishing; 2025.
9 Prestes LM, Castro MÂUL, Souza GAB, Barros LGB, Scotta MC, Pinto LA. Management of pneumonia and pleural effusion in children. *J Bras Pneumol*. 2023;49(6):e20230370. https://doi.org/10.36416/1806-3756/e20230370.

[10] Subramaniam R, Joseph VT, Tan GM, Goh A, Chay OM. Experience with video-assisted thoracoscopic surgery in the management of complicated pneumonia in children. *J Pediatr Surg*. 2001;36(2):316–319. https://doi.org/10.1053/jpsu.2001.20705.

[11] Ponholzer F, Schweiger T, Ghanim B, et al. Analysis of Pain Management after Anatomic VATS Resection in Austrian Thoracic Surgery Units. *J Clin Med*. 2023;13(1):80. https://doi.org/10.3390/jcm13010080.

[12] Graves CE, Moyer J, Zobel MJ, Mora R, Smith D, O'Day M, Padilla BE. Intraoperative intercostal nerve cryoablation During the Nuss procedure reduces length of stay and opioid requirement: A randomized clinical trial. *J Pediatr Surg*. 2019;54(11):2250–2256. https://doi.org/10.1016/j.jpedsurg.2019.02.057.

[13] Arshad SA, Ferguson DM, Garcia EI, Hebballi NB, Buchanan AC, Tsao K. Cryoanalgesia is associated with decreased postoperative opioid use in minimally invasive repair of pectus excavatum. *J Surg Res*. 2022;271:1–6. https://doi.org/10.1016/j.jss.2021.10.011.

[14] Law L, Rayi A, Hendrix JM, Derian A. *Cryoanalgesia*. 2024. Treasure Island (FL): StatPearls Publishing; 2025.

[15] Burstiner L, Al Khalili Y. *Anatomy, Thorax, Pleurae*. 2023. Treasure Island (FL): StatPearls Publishing; 2025.

[16] Li Y, Xu M, He Y, et al. Analgesic effect and safety of intercostal nerve cryoanalgesia after the video-assisted thoracoscopic surgery [in Chinese]. *Zhonghua Yi Xue Za Zhi*. 2015;95(38):3138–3141.

[17] Redden MD, Chin TY, van Driel ML. Surgical versus non-surgical management for pleural empyema. *Cochrane Database Syst Rev*. 2017;3(3):CD010651. doi: 10.1002/14651858.CD010651.pub2.

[18] Soffiati M, Bonaldi A, Biban P. Management of pleural drainage [in Italian]. *Minerva Pediatr*. 2010;62(3 Suppl 1):165–167.