

Post thoracotomy pain management: A review of current available modalities

Address for correspondence:

Dr. Joginder Pal Attri,
Department of
Anaesthesia, Government
Medical College,
Amritsar – 143001, Punjab,
India.
E-mail: jpattri12@yahoo.co.in

Joginder Pal Attri, Ravneet Kaur, Harjinder Kaur, Reena Makhni
Department of Anaesthesia, Government Medical College, Amritsar, Punjab, India

ABSTRACT

Pain after thoracotomy is probably the most severe pain experienced by the patient as incision penetrate several layers of muscle tissue, neurovascular bundles and other structures of the thoracic region. It may be sharp, stabbing, constant shooting neuropathic pain which can be acute (within 30 days of thoracotomy) or chronic (2 to 6 months after thoracotomy). Because of pain, there is shallow breathing and inadequate coughing leading to various types of pulmonary function impairment and complications like retention of secretions, atelectasis, hypoxemia, hypercarbia, respiratory failure and increased chances of re-intubation. Pain also leads to longer stay in the intensive care unit and a delayed mobilization of the patient which ultimately causes increased morbidity and mortality. The chances of deep vein thrombosis are also increased because of delayed mobilization. Sometimes patient may experience post thoracotomy pain syndrome along with changes in psychological behaviour like depression. So management of pain relief is very essential to resume normal activities as soon as possible. This will also lead to increased overall patient's satisfaction. In this article we have highlighted various causes of pain in thoracotomy, its pathophysiology and modalities to relieve pain. This review article aims to highlight all the current practices and modalities so as to manage post-operative pain of thoracotomy in a better manner.

Key words: NSAIDS, pain management, regional anaesthesia, thoracotomy

INTRODUCTION

The International Association for the Study of Pain's defines pain as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage'^[1]. Effective analgesia and perioperative stress response blockade improves outcome and recovery following surgery. Early postoperative pain control not only provide patient's comfort and confidence but also avoid central sensitization and wind up phenomena.

PAIN AFTER THORACIC SURGERY

Post thoracotomy pain is probably the most severe pain experienced after surgery. It is unique as this pain is due to retraction, resection or fracture of ribs, dislocation of costovertebral joints, intercostals nerve injury and/or pleural irritation by chest tube. Inadequate pain management after thoracotomy leads to various respiratory complications^[2]. Pain limits inspiration, causing reflex contraction of expiratory muscles and

decreased functional residual capacity and atelectasis. Postoperatively ineffective coughing due to inadequate analgesia results in retention of secretions, airway closure with resulting pneumonia.

PATHOPHYSIOLOGICAL MECHANISMS OF POST-THORACOTOMY PAIN

The established and most probable mechanisms of pain after thoracotomy may include but are not limited to intercostal nerve damage which can occur due to mechanical damage, compression with a rib retractor and incidental rib fractures^[3], the type of incision: posterolateral approach to thoracotomy is associated with more pain as compared to

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

How to cite this article: Attri JP, Kaur R, Kaur H, Makhni R. Post thoracotomy pain management: A review of current available modalities. Northern Journal of ISA. 2016;1:7-10.

muscle sparing thoracotomy^[4]. Thoracotomy closure with pericostal sutures can contribute to acute and chronic pain after thoracic surgery due to intercostal nerve damage and various other causes such as pre-operative anxiety and personality traits, disarticulation of costochondral and costovertebral junction and many others also contribute to such pain mechanisms.

POST THORACOTOMY PAIN MANAGEMENT

Post thoracotomy pain can be acute (up to 30 days) and chronic (2-6 months) pain after surgery. The aim of postoperative care after thoracotomy is to enable patients to prevent postoperative complications, to resume the normal activities of daily living, reduce the length of hospital stay and increase patient satisfaction. But pain can hinder these and may result in deep-vein thrombosis, sputum retention, increased stress response and poor wound healing.

Preemptive analgesia with adequate intra and postoperative analgesia is the best approach in prevention of both acute and chronic pain in a thoracotomy patient. Among various approaches to analgesia; a multimodal approach is probably the most effective. In post-thoracotomy patients analgesia can be administered as boluses or continuous infusion with pharmacokinetic and patient-controlled systems like PCA (Patient Controlled Analgesia)^[5], Target Control Infusion (TCI) and a new approach of PMA (Patient Maintained Analgesia). A continuous infusion with initial bolus results in rising blood concentrations with time and requires repeated adjustment of the infusion rate. This is overcome by Target-Controlled Infusion (TCI) where the administration is driven by microprocessor-controlled algorithms based on pharmacokinetic models. The main advantage of intravenous PCA is, that it takes into consideration the different subjective pain sensitivities of each patient^[6].

Various pain management modalities which are in current practice for the treatment of post thoracotomy pain are being discussed:

SYSTEMIC ANALGESIA

Systemic analgesia can be given in the form of systemic opioids, Nonsteroidal Anti-Inflammatory Drugs (NSAIDs), paracetamol and ketamine.

Opioids (morphine, fentanyl, pethidine, buprenorphine and tramadol) have been the mainstay of postoperative analgesia. The major problem when using opioids is

their narrow therapeutic window. Even moderate doses of opioids can result in side effects such as nausea or vomiting, somnolence and respiratory depression^[7]. These side effects can be reduced by synergy with drugs which have analgesic overlap without side effects. Various drugs used are cyclooxygenase inhibitors, alpha 2 agonists, Nitric oxide synthetase inhibitors, N-Methyl-D-Aspartate (NMDA) blockers.

Clonidine, an alpha-2 adrenergic receptor agonist, is used in acute and chronic perioperative pain management. Clonidine can be given by various routes: intravenous, oral, topical, intrathecal, epidural and transdermal. Clonidine provides good analgesia at high dosages ($5 \mu\text{g kg}^{-1}$ orally or $4 \mu\text{g kg}^{-1} \text{h}^{-1}$ i.v.) without any depressant effect on respiration or nausea or vomiting.

Another alpha 2-adrenoceptor agonist, *dexmedetomidine* provides sedation in critical care patients and reduces opioid requirements, cause minimal respiratory depression, and improves the outcome. The opioid-sparing property together with anxiolysis and sedation provides analgesia and comfort to postthoracotomy patients thus reducing the number and severity of opioid-induced side effects.

NSAIDs controls the synthesis of prostaglandins, prostacyclins, and thromboxanes by inhibiting cyclooxygenase. These are used as an adjunctive analgesia for thoracotomy pain not covered by the spread of epidural solution or paravertebral block. Senard et al.^[8] examined patients who underwent thoracotomy, treated with thoracic epidural analgesia (TEA) and who were randomized to receive oral celecoxib or not. It was found that postoperative pain scores at rest and with coughing were lower and patient satisfaction was greater in the celecoxib group. But postoperative functional pulmonary assessments and morbidity were comparable between the groups.

REGIONAL ANALGESIA

This can be given in the form of intercostal, paravertebral, interpleural, epidural and spinal blockade. The use of preemptive analgesia with adequate intra- and post-operative analgesia is best for the prevention of chronic pain in a thoracotomy patient. A multimodal approach is the most effective mode of analgesia.

THORACIC EPIDURAL ANALGESIA

Epidural analgesia is regarded as the gold standard for

pain therapy after thoracic surgery. Epidural analgesia can be performed using either a lumbar or a thoracic approach. The epidural space is bounded anteriorly by the posterior longitudinal ligament, laterally by the pedicles and the intervertebral foramina and posteriorly by the ligamentum flavum and the anterior surface of the lamina. The contents of the epidural space are nerve roots, fat, areolar tissue, lymphatics, arteries, and the extensive vertebral venous plexus. Clinical studies shows that epidural is more effective than intercostal, interpleural, and i.v. opioid analgesia^[9]. A Randomized Controlled Trial (RCT) was conducted comparing epidural analgesia with intravenous (i.v.) morphine. It was found that postoperative pain intensity scores at rest, on coughing, and on movement were significantly lower in patients who received a combination of epidural bupivacaine 0.1% and morphine 0.05–0.1 mg ml⁻¹^[10]. The pain at 2 and 6 months in the epidural group was significantly lower than that in the i.v., morphine group, concluding epidurals may be effective for prevention of chronic pain after thoracotomy.

The main advantage of epidural block is its sympathetic block which may prevent sympathotonic state caused by surgical manipulation and trauma to cardiac parasympathetic nerves. The incidence of atrial fibrillation and paroxysmal supraventricular tachycardia was significantly lower in patients who received epidural bupivacaine 0.25% than in those who had epidural morphine^[11].

The drugs that can be infused for TEA include local anaesthetic alone, opioids alone, or the combination of local anaesthetic and opioids. Combining thoracic epidural local anaesthetic and opioids produces superior analgesia compared with using epidural opioids or local anaesthetic alone^[12]. Opioids may be used alone for TEA in patients with marginal hemodynamic status. Epidural or intrathecal clonidine as an adjuvant to local anaesthetic also prevent the development of chronic post-surgical pain and hyperalgesia after major surgery^[13,14].

Bupivacaine is a racemic mixture of S and R enantiomers, but evidence suggests the R enantiomer has greater cardiotoxicity. The S enantiomers, levobupivacaine and ropivacaine because of a potentially lower cardiotoxic profile have been shown to be less cardiotoxic than bupivacaine. But there is no clinical advantage of ropivacaine or levobupivacaine over bupivacaine for TEA because plasma bupivacaine concentrations during thoracic epidural infusions rarely approach toxic concentrations in adults.^[15]

Various adverse effects with epidural analgesia include block failure, hypotension, urinary retention, pulmonary complications, and nausea.

INTRATHECAL ANALGESIA

Intrathecal analgesia is another mode of analgesia. Intrathecal opioids have been used as an adjunct to post thoracotomy analgesia^[16]. The advantages of the technique are simplicity, reliability and potentially fewer adverse effects from systemic opioid absorption. However this technique has an increased risk of respiratory depression and post spinal headache^[17].

PARAVERTEBRAL BLOCK

Paravertebral blockade is a unilateral block suitable for pain treatment after lateral thoracotomy. Paravertebral blockade can be performed either percutaneously or intra operatively under visual control to avoid complications. Paravertebral block is an effective analgesia technique in patients who have coagulopathy as epidural insertion may be contraindicated because of the risk of spinal haematoma and cord compression^[18].

In a study conducted on 56 patients undergoing thoracotomy, the efficacy of a continuous paravertebral block with 0.5% bupivacaine was investigated. It was found that paravertebral blockade provided significantly better pain relief and pulmonary function with less papaveretum consumption after thoracotomy during the first 48 hours (bupivacaine group: 14 mg versus control group: 136 mg)^[19].

INTERCOSTAL NERVE BLOCK

Intercostal nerve blockade can be given as a single injection of local anaesthetics in multiple intercostal nerves before closure of thoracotomy incision or a continuous infusion. But a single shot intercostal nerve block do not provide effective long term analgesia and need to be repeated. Continuous infusion can be given with intercostal catheter combined with patient controlled analgesia^[20].

OTHER METHODS

Cryoanalgesia involves freezing of an intercostal nerve by intraoperative application of a cryoprobe to its posterior aspect^[21]. A study was done comparing cryoanalgesia with a control group that did not receive cryoanalgesia. It suggested that there were no advantages associated with the treatment by cryoanalgesia. Approximately 20% of

the treated patients developed intercostal neuralgia by 6 weeks after surgery^[22].

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

TENS produce analgesia by modulation of nociceptive input in the dorsal horn of the spinal cord through peripheral electrical stimulation of large sensory afferent nerves, the so-called gate control theory of pain^[23]. TENS is not a reliable pain relief method in the treatment of acute post thoracotomy pain, but can be useful in treatment of chronic post thoracotomy pain^[24]. The effectiveness of TENS as an adjunct to TEA was evaluated and was found that adding TENS to epidural analgesia led to a significant reduction in pain with no sequelae; thus a valuable strategy to alleviate postoperative pain following thoracic surgery^[25].

PREEMPTIVE ANALGESIA

Is required to prevent the central sensitization caused by incisional and inflammatory injuries. Preemptive multimodal analgesia is used now a days. Combining opiates, local anaesthetics, NSAIDS, and/or neuroaxial blockade prior to surgery provides optimal perioperative analgesia and decreases the incidence of chronic pain^[26].

CONCLUSION

Pain is a subjective feeling by the patient and should be managed promptly. There are a variety of methods available for post thoracotomy pain management. Depending upon the severity of pain, it can be managed with medical management, neuraxial block or others regional block. Thoracic epidural analgesia or nerve blocks are so far considered as best option but one needs to consider personnel and equipment resources available. A combination of local anaesthetics along with opioids can be given to reduce the agony of the patient and early discharge from the hospital.

REFERENCES

- Merskey H, Bogduk N. Classification of chronic pain. 2nd ed. Seattle: International Association for the Study of Pain; 1994. p. 3–4. Available from: <http://www.iasp-pain.org/Taxonomy> ISBN: 0-931092-05-1.
- Ochroch EA, Gottschalk A. Impact of acute pain and its management for thoracic surgical patients. *Thorac Surg Clin* 2005;15:105-21.
- Gerner P. Post-thoracotomy pain management problems. *Anesthesiol Clin* 2008;26:355–66.
- Ochroch EA, Gottschalk A, Augoustides JG, Aukburg SJ. Pain and physical function are similar following axillary, muscle-sparing vs posterolateral thoracotomy. *Chest* 2005; 128:2664–70.
- Lehmann KA. Patient-controlled analgesia for postoperative pain. In: Benedetti C, Chapman CR, Gibson G, editors. *Advances in Pain Research and Therapy*. New York: Raven Press Ltd; 1990. p. 297–324.
- Salzer GM, Klingler P, Klingler A and Unger A. Pain treatment after thoracotomy: Is it a special problem? *Ann Thorac Surg* 1997; 63:1411–4.
- Jordan C, Lehane JR, Robson PJ and Jones JG. A comparison of the respiratory effects of meptazinol, pentazocine and morphine. *Br J Anaesth* 1979;51: 497–502.
- Senard M, Deflandre EP, Ledoux D, Roediger L, Hubert BM, Radermecker M, et al. Effect of celecoxib combined with thoracic epidural analgesia on pain after thoracotomy. *Br. J. Anaesth* 2010;105:196–200.
- Gottschalk A, Cohen S, Yang S, Ochroch EA. Preventing and treating pain after thoracic surgery. *Anesthesiology* 2006;104:594–600.
- Sentürk M, Ozcan PE, Talu GK, Kiyan E, Camci E, Ozyalcin S, et al. The effects of three different analgesia techniques on long term post-thoracotomy pain. *Anesth Analg* 2002;94:11–5.
- Oka T, Ozawa Y, Ohkubo Y. Thoracic epidural bupivacaine attenuates supraventricular tachyarrhythmias after pulmonary resection. *Anesth Analg* 2001;93:253–9.
- Macias A, Monedero P, Adame M, Torre W, Fidalgo I, Hidalgo F. A randomized, double-blinded comparison of thoracic epidural ropivacaine, ropivacaine/fentanyl, or bupivacaine/fentanyl for postthoracotomy analgesia. *Anesth Analg* 2002;95:1344 –50.
- Hall JE, Uhrich TD, Ebert TJ. Sedative, analgesic and cognitive effects of clonidine infusions in humans. *Br J Anaesth* 2001;86:5–11.
- Lavand'homme P, De Kock M. The use of intraoperative epidural or spinal analgesia modulates postoperative hyperalgesia and reduces residual pain after major abdominal surgery. *Acta Anaesthesiol Belg* 2006;57:373–9.
- Block BM, Liu SS, Rowlingson AJ, Cowan AR, Cowan JA Jr, Wu CL. Efficacy of postoperative epidural analgesia: A meta analysis. *JAMA* 2003; 290:2455– 63.
- Mason N, Gondret R, Junca A and Bonnet F. Intrathecal sufentanil and morphine for postthoracotomy pain relief. *Br J Anaesth* 2001;86:236–40.
- Cousins MJ, Mather LE. Intrathecal and epidural administration of opioids. *Anesthesiology* 1984;61:276–310.
- Karmaker MK. Thoracic paravertebral block. *Anesthesiology* 2001;95:771–80.
- Sabanathan S, Mearns AJ, Bickford Smith PJ, Eng J, Berrisford RG, et al. Efficacy of continuous extrapleural intercostals nerve block on post-thoracotomy pain and pulmonary mechanics. *Br J Surg* 1990;77:221–5.
- Detterbeck FC. Efficacy of methods of intercostal nerve blockade for pain relief after thoracotomy. *Ann Thorac Surg* 2005;80:1550–9.
- Maiwand MO, Makey AR, Rees A. Cryoanalgesia after thoracotomy. Improvement of technique and review of 600 cases. *J Thorac Cardiovasc Surg* 1986; 92:291–5.
- Muller LC, Salzer GM, Ransmayr G, Neiss A. Intraoperative cryoanalgesia for postthoracotomy pain relief. *Ann Thorac Surg* 1989;48:15–8.
- Wall PD. Cancer pain: Neurogenic mechanism. In: Fields HL, Dubner R, Cervero F, editors. *Proceedings of the 4th World Congress on Pain*. Advances in Pain Research and Therapy. New York: Raven Press; 1985. p. 575–87.
- Stubbing JF, Jellicoe JA. Transcutaneous electrical nerve stimulation after thoracotomy. *Anaesthesia* 1988; 43:296–8.
- Chandra A, Banavaliker JN, Das PK, Hasti S. Use of transcutaneous electrical nerve stimulation as an adjunctive to epidural analgesia in the management of acute thoracotomy pain. *Indian J Anaesth* 2010;54:116–20.
- Hazelrigg SR, Cetindag IB, Fullerton J. Acute and chronic pain syndromes after thoracic surgery. *Surg Clin North Am* 2002;82:849–65.