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Thoracic Epidural Versus Continuous Intercostal Catheter For Patients Undergoing Video Assisted Thoracoscopic Surgery (VATS)

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Abstract

Advances in technology have pushed many practitioners towards the implementation of minimally invasive surgery. Many different specialties have rapidly adopted this new approach and patient outcomes have improved as a result of this transition. One specialty, thoracic surgery, has evolved with this change through the development of video assisted thoracoscopic surgery (VATS). Despite improved patient outcomes, thoracic surgery remains one of the most painful procedures that a patient can endure. Although there are many different analgesic modalities available, the gold standard for post-operative analgesia in this patient population remains unknown. The aim of this literature review is to compare the analgesic benefits of thoracic epidural analgesia to intercostal analgesia.

Introduction

With the development of new technology and changes in health care policy, the culture of medicine has also undergone a major shift. Outcomes today are no longer measured simply by patient improvement but are instead driven by patient satisfaction and reduction of overall costs. Many specialties have embraced new developments in technology and, by far, one of the most interesting changes has occurred in the specialty of thoracic surgery. Surgical thoracotomy has long been considered one of the most painful procedures a patient can undergo. The development of video assisted thoracoscopic surgery (VATS), however, has virtually replaced the need for thoracotomies all together. Many practitioners have embraced this new technology utilizing a minimally invasive approach given its potential to improve patient outcomes and decrease postoperative pain scores. As with all new procedures, anesthesia has evolved to adapt to this new set of surgical requirements and patients' needs.

While the development of VATS has been pivotal in improving patient outcomes, the procedure is not pain-free. There is great debate amongst the anesthesia and surgical communities regarding the best method to provide analgesia to patients undergoing this procedure. The parties are largely divided between the use of continuous intercostal catheters (ICC) and that of thoracic epidural analgesia (TEA). Within these two groups, there also lies variation in the use of patient controlled analgesia (PCA) for added analgesia. While these are the primary forms of analgesia for VATS utilized in many surgical centers, other methods include PCA alone and paravertebral block. When performed, epidurals are the responsibility of anesthesia while intercostal catheters are placed intraoperatively by the surgical team, thus leading to division of both

responsibility and reimbursement within this surgical sub-specialty. Given these considerations, identifying the superior analgesic delivery system is essential to improving patient outcomes and minimizing unnecessary cost.

Background

Physiology of Pain

Pain is a complex process for both the patient and the anesthetist tasked with managing it. In order to treat pain it is imperative that a thorough understanding of the pathophysiology first be established. From an evolutionary perspective, pain is a protective mechanism designed to alert the body to a stimulus and then subsequently react to the stimulus. Pain is divided into several subsets including speed of pain such as fast or slow, and type of pain such as sharp or dull. It may be acute or chronic and may occur anywhere in the body. Pain is processed by receptors, which then relay the message to the spinal cord via different types of fibers, often A delta and C fibers (Hall & Guyton, 2011). After entering the spinal cord, these pain messages are further relayed via one of two pathways towards the brain. Fast pain is transmitted via the neospinothalamic tract while slow pain is transmitted via the paleospinothalamic pathway. In the process these pain fibers pass through various lamina within the dorsal horn of the spinal cord before traveling towards the brain. Fast pain primarily travels directly towards the thalamus while slow pain terminates in inferior segments such as the medulla or pons (Hall & Guyton, 2011). These messages are relayed via the release of substances known as neurotransmitters. While there are many different neurotransmitters constantly circulating throughout the body at any given moment, two have been identified as being directly linked to the pain process. Glutamate is an excitatory neurotransmitter associated with

fast pain while Substance P is associated with chronic pain. All of these relayed messages are processed by the reticular formation, thalamus and cerebral cortex (Hall & Guyton, 2011). The many different factors involved in the transmission and perception of pain contribute to its importance in anesthetic management.

Gate Control Theory

In addition to the basic physiology of pain, there are several pain theories that guide anesthetists in analgesic management of all patients undergoing surgery. One of the most popular theories is the gate control theory. This theory was first presented back in the 1960's and has been a mainstay of pain management for the past fifty years. This theory suggests that much like a gate in the road, the neuronal system has its own mechanisms at various levels of the spinal cord to modulate the interaction between painful stimuli and sensory perception in the higher centers of the brain (Treede, 2016). This theory led to the proposition that blocking pain prior to modulation in the spinal cord could "gate" the pain from being transmitted. This theory of pain control is the driving force behind pre-emptive pain control. The use of epidural analgesia in many surgical procedures, including VATS, is implemented based upon this same theory.

Intercostal Catheter

An intercostal catheter (ICC) is placed by the surgeon either at the start of the procedure or at the conclusion of the procedure. The On-Q© pain pump is a small portable device that delivers a continuous infusion of local anesthetics at the surgical site that may remain in place for up to 5 days (Muzaffar, 2016). The patient may remove it independently if discharged home or it may be removed by the nurse if the patient remains in the hospital. This is unique to the On-Q© system. There are relatively few

risks associated with this system, however there is always a risk of migration of the catheter and subsequent intra-arterial infusion of the medication (Muzaffar, 2016). This places the patient at risk for toxicity and is associated with patient mortality. While there are several other continuous infusion devices available, the On-Q system remains one of the most popular.

Video-Assisted Thoracoscopic Surgical Technique

Advances in minimally invasive surgery have improved patient outcomes across the health care spectrum. The transition from open thoracotomy to minimally invasive video assisted thoracoscopic surgery (VATS) has had a profound impact on both morbidity and mortality in patients undergoing thoracic surgery (Steinthorsdottir et al., 2013) . While the potential to convert to open thoracotomy always exists, advances in technology and surgical technique continue to minimize the need for conversion to more drastic measures. VATs may be performed by either a triple port or single port approach. Regardless of approach, patients are positioned in the lateral or modified lateral position to enhance surgical exposure. In the single port technique, typically a 4-5 mm mini-thoracotomy incision is made at the 4^{th} to 6^{th} intercostal space at the anterior axillary line (Wang, et al, 2015). The multiport technique includes both the mini-thoracotomy in addition to a secondary port at the midraxillary line in the 8^{th} intercostal space and a final port located at the edge of the scapular (Wang, et al, 2015). The procedure is performed with and without rib retraction, a technique often associated with increased pain post-operatively. In addition, the procedure may be performed under general anesthesia with a double lumen endotracheal tube or awake at certain centers. A chest tube is often placed at the end of the procedure. There is some variability amongst technique from center to

center. Surgical approach may vary depending upon the operative area and possible lymph node dissection may warrant extension of variation of approach.

Literature Review

The rapid popularization of VATS in comparison to the traditional thoracotomy approach has led many anesthetists to question which method of analgesia is indeed superior. Unfortunately, current research on the topic is limited; this has left many providers referring back to thoracotomy protocol for analgesia during VATS, despite the use of a drastically different surgical approach. A thorough review of PubMed, Cochrane Systematic Review, and Medline yielded limited pertinent level I evidence, further emphasizing the timely significance of this research question. Several keywords and phrases were searched including continuous intercostal catheter, On-Q©, thoracic epidural, and analgesia for video-assisted thoracoscopy.

Retrospective Analysis

In the study by Wu et al. (20116), a retrospective analysis was performed to assess the efficacy of post-operative pain utilizing an intercostal catheter in patients undergoing a single port VATS. The patient population included those undergoing wedge resection, anatomic resection, or lymph node resection. This single center study compared fifty patients who received ICC for pain relief with fifty patients who did not. Single port approach was performed in the lateral position with a small incision made at the fourth or fifth intercostal space along the anterior axillary line. At the conclusion of the procedure, an 8Fr catheter was utilized to advance a 7fr 20 cm catheter over a guide-wire under direct visualization. Patients received a continuous infusion of 0.2% Levobupivicaine via the catheter at 2.5 mL/hr. In addition, patients received an oral

analgesic combination of Acetaminophen 500 mg Q6H, Ibuprofen 600 mg Q8H, and Tramadol Q6H. Morphine 0.1 mg/kg was administered for patients with NRS >3 at rest or NRS >5 with activity. Postoperative pain scores were recorded through discharge and additional narcotic requirement was also evaluated as a primary endpoint. Pain scores were measured utilizing the numerical rating scale (NRS) or the visual analog scale (VAS). The study results showed that patients with an ICC had lower pain scores during the initial postoperative period and decreased utilization of additional narcotics. While these findings support the use of a continuous ICC for postoperative pain relief, the study has several limitations. The study does not evaluate multiple analgesic interventions, but rather compares ICC to the absence of intervention. Additionally, despite propensity matching, demonstrating efficacy of the ICC may be limited by the small study population. This study was also unique in that the center utilizes a single port technique, which differs from many others in the review, possibly limiting the external validity of the findings.

Two additional retrospective analyses were identified during the search for this clinical inquiry. In the study by Gebhardt et al. (2013), continuous ICC, specifically utilizing the ON-Q© system, were compared to epidurals for pain control in patients undergoing thoracotomy. The authors reviewed a total of fifty patient records for individuals who underwent muscle-sparing thoracotomies, performed at a teaching institution by a single surgeon. Thoracic epidurals were placed by anesthesia at the level of T7 prior to induction of general anesthesia. Epidural patients initially received a mixture of 0.1% racemic bupivicaine and were later transitioned to levobupivicaine combined with 5 mcg/mL of fentanyl started at 0.1 mL/kg/hr and then titrated to provide

adequate analgesia. At the conclusion of the procedure, the surgical team placed the ON-Q© local anesthetic infiltrating catheter under direct visualization. Patients with the ICC received a bolus of 5 mL of 0.5% ropivicaine followed by an infusion with 0.5% Ropivicaine at 2 mL/hr. In addition, patients with the catheter received local infiltration at the surgical site with 0.5% Ropivicaine. Intravenous hydrocodone PCA was started for patients in the ICC group. Nursing staff used the NRS to assess level of pain throughout patients' admissions. Average daily pain and maximum pain were identified as two of the primary endpoints. Patients in the epidural group had lower average pain scores on postoperative day 2 and lower maximum pain scores on day 1 and day 2 when compared to the ICC group. Although these results favor the epidural for providing superior pain control in patients undergoing a muscle sparing thoracotomy, patients were discharged earlier with the ON-Q© and required fewer bladder catheterizations. Study results did not account for total amount of additional narcotic used by patients, further increasing the limitations of these findings. Furthermore, only one pain scale was used for assessment and there was no indication of other metrics such as patient satisfaction or level of activity during maximal pain. While this study provides insight into the potential benefit of ICC for thoracotomy, the surgical technique and other limitations as noted give the study a poor level of evidence for determining optimal analgesia in VATS.

In a larger retrospective analysis by Elsayed et al. (2012), patients undergoing lung resection via thoracotomy received either a thoracic epidural or paravertebral catheter. Despite the author's intent to compare the two analgesic techniques, pain scores were not independently identified as a primary endpoint of the study. Rather, postoperative outcomes such as respiratory complications, intensive therapy unit (ITU)

readmission, in-hospital mortality, ITU length of stay (LOS), and total hospital LOS were measured instead. Use of a thoracic epidural involved insertion prior to induction of general anesthesia at the level of T7 and initiation of a mixture of 0.1% racemic bupivicaine. This continuous infusion was later changed to levobupivicaine and 5 mcg/mL of fentanyl started at 0.1 mL/kg/hr. The continuous paravertebral catheter was placed under direct vision by the operating surgeon. An infusion of 0.25% racemic bupivacaine later transitioned to levobupivicaine was started at a maximum dose of 0.1 mL/kg/hr and titrated to provide adequate analgesia. Patients with the paravertebral catheter also received intravenous opioids given at the discretion of the anesthesiologist during the procedure, and were started on a morphine PCA with 1 mg bolus and 5 minute lockout. The study concluded that in summary, patients with paravertebral blocks had significantly shorter hospital length of stay, which resulted in a decreased overall patient expenditure. The greatest limitation in this study lies in the lack of statistical analysis of pain levels. As pain scores were not measured and differences in post-op complication rates were largely insignificant, adequacy of analgesic method was instead determined primarily by decreased cost. Although these three retrospective analyses provide some insight into the benefits of epidural or intercostal catheter for postoperative pain analgesia, they lack specificity in comparing the two modalities for patients undergoing VATS.

Ambrogi et al. (2014), examined the differences in patients undergoing a single-port VATS with an INB vs. the use of TEA with triple-port VATS. The study was developed as a division of an existing study examining awake thoracic surgery. Patients with interstitial lung disease scheduled to undergo biopsy via VATS were selected and

divided into the two groups. The retrospective study was non-randomized and included a total of 40 patients. Those who were selected for the TEA group received an epidural placed at the T4-T5 level. A bolus of 5 mg of ropivicaine plus 5 mcg sufentanyl was given followed by a continuous infusion of ropivicaine 2 mg/mL (5 mL/hr) started 20 minutes prior to biopsy with patient lying with operative side down. In the block group, patients received an aerosolized 5 mL solution of 2% lidocaine administered for 5 minutes to suppress cough reflex prior to block placement. After that period, 20-30 mL of a mixture of 2% lidocaine and 7.5% ropivicaine was administered as an intercostal block. Patients in the epidural group underwent VATS via three ports including a camera port placed in the eighth intercostal space and two operative ports placed in the fifth intercostal space. Patients in the block group underwent VATS via single port placed either in the fourth or eighth intercostal space, depending on site of biopsy. All patients had a chest tube placed at the end of the procedure. With the exception of two conversions to general anesthesia, all procedures were performed under monitor anesthesia care. Unlike other studies discussed, this study utilized the visual analog scale (VAS) to measure the primary endpoint of pain control. While the VAS is a validated tool for pain management, the study did not assess a baseline VAS and was assessments were lead by multiple providers. Pain was measured both as a basal value and also with coughing at 24 and 48 hours. The study found that there was not major difference in analgesic benefit between the two modalities; however, other outcomes such as speed of recovery favored the single port VATs with intercostal block.

Cohort Studies

Further review of the literature yielded a prospective observational cohort study by Wildgaard et al (2012). In this study, the researchers first performed a pilot utilizing a diagram of the thorax and determined that the greatest area of discomfort was that surrounding the chest tube. A total of 48 patients undergoing three-port video-assisted thoracoscopic surgery (VATS) without rib retractor for lobectomy were selected for the study. Patients received a paravertebral block between T3 and T8 with 15 mL of 0.5% bupivacaine. A flexible catheter was then placed along the intercostal nerve bundle and a continuous infusion of 0.25% bupivacaine at 6 mL/hr was initiated. Patients also received a combination of 2g of paracetamol, 800 mg Ibuprofen, and 600 mg of gabapentin preoperatively. Induction was standardized for all patients. Surgical incisions were carried out by two separate surgeons, however technique was consistent between both. Pain scores were measured using the numerical rating scale (NRS) throughout the post-operative course. This study was the first reviewed to outline specific activity (such as getting out of bed) in association with NRS scores. The study found that the greatest incidence of pain was within the first six hours post-operatively. Patients reported the most severe pain localized to the chest drain area with a decrease in overall pain scores following chest tube removal. Although this study does not offer comparison of the two analgesic delivery methods being analyzed in this review, it did find that ICC combined with non-opioid analgesics provides adequate analgesia for the immediate postoperative period. This study also provided the greatest detail regarding measurable activity and associated pain level—an important and clinically relevant aspect of patient outcomes.

In another cohort study by Hung et al. (2015), the researchers compared epidural analgesia with intercostal blockade in patients undergoing non-intubated VATS. This

retrospective analysis focused on patients with lung cancer undergoing resection via a three-port VATS technique. For the patients in the epidural group, a catheter was inserted to the T5/6 interspace to achieve a sensory block between T2 and T9 with 2% lidocaine. Sedation was titrated to maintain bispectral index (BIS) at a value between 40-60 during the procedure and additional fentanyl was administered to maintain respirations between 12 and 20 breaths/minute. Intercostal nerve block (INB) patients received local infiltration with 2% lidocaine at the thoracoscopy port site. After the lung was collapsed, INB was administered under direct vision with a 25 gauge infusion needle and 1.5 mL of 0.5% bupivacaine was administered between the third to eighth intercostal nerves. All patients received an intrathoracic vagal block to prevent coughing with 2-3 mL of bupivacaine. The VATS was performed with camera port placed in the seventh or eighth intercostal space, and two surgical ports placed between the fifth and seventh intercostal spaces. All patients had a chest tube placed at the end of the procedure and rib retractors were avoided in all cases. The study did not provide any tool for pain assessment in the final results. Additionally, although the study reported that post-operative pain control was adequate in both groups, pain was not actually measured as a primary or secondary endpoint in this study. While this study provided excellent insight into the logistics of how to perform a non-intubated VATS, it provided little insight into the superior analgesic method.

Randomized Studies

During the literature search, several relevant randomized studies were identified. One study, by Yoshioka et al. (2006), aimed to validate the efficacy of epidural analgesia in patients undergoing video assisted thoracoscopic surgery (VATS). Many of the studies

discussed previously have evaluated a combination of analgesic interventions; this, however, was the only study randomized study identified during the literature review to compare analgesic interventions to a control group. The study was conducted with an epidural placed at the T5/6 or T6/7 level prior to induction of general anesthesia. After completion of surgery, patients received a single injection of 5 mL of 0.25% bupivacaine hydrochloride via the epidural catheter followed by a continuous infusion of 80 mL of 0.25% bupivacaine hydrochloride and 1 mg of fentanyl citrate using a balloon infuser at a rate of 2 mL/hr. Interestingly, the epidural was not dosed prior to the completion of surgery. No narcotic medications were given during surgery and both groups were induced and maintained with a standardized general anesthetic protocol. The VATS was performed with a single port and a small lateral thoracotomy. Additional analgesics were administered if postoperative pain relief could not be achieved. Pain scores were assessed with a VAS both at rest and during activity however the extent of activity, such as getting out of bed, was not clearly identified by the researchers. The results of the study favored the analgesic properties of the epidural analgesia when compared to the control group. This study is unique in that no narcotics were administered to the control group. While this study validated the benefits of epidural analgesia for patients undergoing VATS, lack of a secondary intervention group diminishes the study's overall level of evidence.

Further review of the literature revealed two additional randomized studies, neither of which included a control group. In the study by Hotta et al. (2011), patients undergoing VATS for lung resection were divided into a continuous extrapleural block group and a continuous epidural block group. This prospective, randomized study measured pain utilizing the VAS as primary endpoint, and need for additional analgesia

as a secondary end point. Unlike many of the other studies discussed, this was the first to measure pain exclusively as a primary endpoint. This study was the first identified in the literature search to outline specific details of the pain assessment including time intervals and level of activity during which pain was assessed. Prior to induction of general anesthesia, an epidural catheter was placed at T5/6 or T6/7 level and the patient was then positioned in a left lateral knees-to-chest position. An initial bolus of 5 mL of 0.75% ropivacaine was administered followed by a second bolus of 5 mL given at the end of surgery. Patients in the continuous extrapleural block group had a catheter with five side ports inserted by the surgeon under video monitor guidance prior to chest closure. These patients received a bolus dose of 5 mL of 0.75% ropivicaine which was followed by a second bolus of 5 mL at the end of surgery. Both groups received a continuous infusion of 0.2% ropvicaine at 4 mL/hour, continued over 60 hours. General anesthesia was standardized between the two groups to achieve a BIS value between 40 and 60. Details of the surgical technique such as number of ports and need for a chest tube were not included in the study methods. Although the study was relatively small, the results indicated that there was no statistical difference in either primary or secondary endpoints between the two groups.

In another randomized study by Luketich et al. (2005), PCA plus ICC was compared to TEA alone in patients undergoing thoracotomy. Although this research is the oldest included in this review and does not focus on VATS, it provides an excellent example of a well-conducted randomized trial. This study, unlike the prior, was a large multicenter study with a larger patient population, thus adding to the study's overall statistical significance. The study's patient population included those undergoing

thoracotomy with an existing diagnosis of lung cancer and those with a single pulmonary nodule. Following randomization, patients in the epidural group had a catheter placed at T3-T6 level. After a test dose, a continuous infusion of 0.125% bupivacaine and 0.05 mg/mL morphine was initiated at a rate of 4-8 mL/hr. The INB group received 10 mL of 0.25% bupivacaine percutaneous nerve block injected prior to thoracotomy. The intercostal catheter was placed at the eighth intercostal space and tunneled upward. A bolus dose of 10 mL of 0.5% bupivacaine was injected in the operating room followed by a continuous infusion of 0.25% bupivacaine at 1 mL/10 kg/hr. This was continued for a minimum of 72 hours. For patients in this group, a PCA was initiated with 1 mg of morphine on demand every 8 minutes with a 4-hour maximum dose of 30 mg. The PCA was discontinued within 4 to 6 hours of initiation of the intercostal infusion and oral pain medications. Similar to the randomized study performed by Hotta et al (2011) included in this review, pain was measured as a primary endpoint. However, unlike the previous study, multiple self-reported pain tools were utilized and averaged together, including the VAS, box score, and a categorical scale. A total of 12 pain observations were reported in the study; however the authors did not differentiate between levels at rest and during activity. The study ultimately concluded that there was no difference in average postoperative pain scores between the two groups. The epidural group, however, required greater additional narcotic group when compared to the ICC and PCA group. Again, while this study is older, its thorough design highlights the gaps in level of evidence seen in the study by Hotta et al (2011) and other studies analyzed in this review.

Systematic Review

Review of the literature yielded only one systematic review focused upon the clinical question of interest. Steinthorsdottir et al (2013) presented a systematic review of regional analgesia for video assisted thoracoscoipc surgery (VATS). This comprehensive analysis included several types of regional interventions including epidurals and intercostal catheters. This study further emphasized the gaps in the research, and—although 17 studies were included—only one by Hotta et al (2011), as discussed above, compared the two primary modalities discussed in this paper. The authors concluded that although thoracic epidurals may provide adequate analgesia for patients undergoing VATS, it cannot be delineated as to whether or not it is a superior modality.

Discussion

Ultimately, review of literature confirmed the current absence of a gold-standard for superior analgesic intervention in patients undergoing video-assisted thoracoscopic surgery (VATS). Although this surgical technique has grown in popularity along with documented improvements in patient outcomes, it remains unclear as to whether or not epidural or intercostal catheterization provides greater analgesia. One of the most interesting findings was the number of studies that compare the analgesic properties of these two interventions without measurement of pain as a primary endpoint. This lack of consensus between studies on the most clinically relevant research endpoint is an overarching issue. Many of the studies, which did measure pain outcomes, utilized either the numeric rating scare (NRS) for pain assessment and or the visual analog scale (VAS). While both are validated tools, there validity is poor when utilized independently. In many of the studies, although a pain assessment tool was identified, additional information related to patient activity or presence of a chest tube was often excluded from

the data. In the study by Hotta et al (2011) multiple self-reported pain tools were utilized and averaged together, including the VAS, box score, and a categorical scale with a total of 12 pain observations reported. The study found no major difference between the analgesic benefits of the two intervention, however it serves as a benchmark for pain measurement in future studies aimed at comparing analgesic modalities. Many of the study designs were small and retrospective in nature. Of the randomized studies, the research conducted by by Luketich et al. (2005) provides interesting historical comparison of the two analgesic interventions. Although the study is focused upon patients undergoing a thoracotomy, one intervention was not found to be superior to the other. However the epidural group did require greater additional narcotics post-operatively. A similar study performed by Gebhart et al., (2013) comparing these two analgesic interventions in patients undergoing a minithoracotomy found that the patients in the epidural group had lower average pain scores on postoperative day 2 and lower maximum pain scores on day 1 and day 2 when compared to the intercostal catheter group. When pain was evaluated as the independently as an endpoint, the literature review revealed that epidural was largely superior when compared to the continuous intercostal catheter. Unfortunately, in most of the research pain was not measured as a primary endpoint and alternative patient outcomes, such as length of hospital stay, are the driving force supporting continuous intercostal catheters for analgesic management. A larger patient population with a standardized surgical technique (i.e. one-port vs. three-port) could produce a higher level of validity within the existing body of research. Much of the research presented above focused upon small patient populations of 50-200 patients leading to limited implications for clinical practice. The absence of a validated,

blinded, randomized control trial produces weak conclusions based upon the research presented. Greater specificity with regards to intercostal blocks as a single injection or continuous infusion would provide further insight into the analgesic benefits of intercostal blockade. This research has highlighted the numerous analgesic options available to patients undergoing VATS. Although a clearly delineated superior analgesic was not identified, it is clear that thoracic epidural and continuous intercostal catheter are capable of providing adequate post-operative analgesia for patients undergoing VATS.

Limitations

Several limitations within the research have been identified. The pace of the transition from traditionally thoracotomy to minimally invasive surgery techniques has clearly exceeded that of the anesthetic transition. Overall, despite the increasing incidence of lung cancer, and thus the increase in patients requiring surgical interventions, the research on this topic remains largely stagnant. With so many variables associated with the video assisted thoracoscopic surgery (VATS) technique including single port versus multiport, patient pathology and presentation, and surgical preference, the technique that provides superior analgesia seems to be overlooked. Many of the studies discussed are retrospective or controlled studies. There are several recommendations for further research. The largest gap in the research is the absence of blinded randomized controlled studies comparing the two analgesic techniques independently. An additional gap in the research is isolating the surgical technique and including additional surgical manipulation such as rib retraction which is associated with increased pain. Finally, if analgesic benefit of either intervention is to be truly evaluated on an unbiased level, pain must be evaluated. When discussing analgesic benefits of one

intervention versus another, it is imperative that at a minimum a patient reported pain assessment be included. To further build on this, a pre-operative assessment of pain, nursing assessment of pain, and ability to perform activities that have been deemed strenuous would also add to the validity of further research.

Implications for Practice

As the economic toll of healthcare continues to rise, in addition to the number of patients discharged on opioid medications, it is of the utmost importance to identify which analgesic intervention is superior not only in the perioperative period but also postoperatively in patients undergoing video assisted thoracoscopic surgery (VATS). Pain is often regarded as the 6th vital sign and oversight of such a sensitive matter has the potential to further add to this burden of healthcare. In addition to airway management, pain is often at the forefront of the anesthetists mind. This gap in research makes it challenging to advocate for patients who may suffer from both acute post-operative pain and chronic pain after discharge from the hospital.

Conclusion

As this field continues to move forward into non-intubated video assisted thoracoscopic surgery (VATS) procedures, there will likely be increasing interest as to which analgesic intervention not only improves patient outcomes, but improves those in regard to pain scoring. Much of the research discussed found equivocal analgesic benefits between the two techniques. However, many studies cited the intercostal blockade with greater benefit due to improved post-operative patient outcomes. Unfortunately, patient outcomes were often measured by primary endpoints focused on hospital costs, such as shortened hospital stay and fewer catheterizations, prompting questions as to the true

aims of these studies. Even with the rising popularity of VATS, thoracic surgery is still considered one of the most painful procedures that a patient can undergo, and thorough review of the literature highlights the obvious need for further research in the arena of optimizing pain control.

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