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Utilization of Novel Anesthesia Techniques in Organ-Sparing Surgeries

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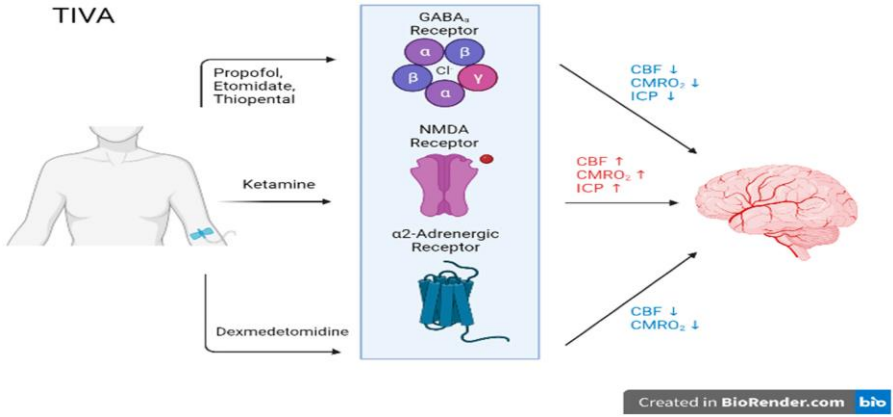
ABSTRACT

The most significant factor is the potential improvement in morbidity rates achieved by the utilization of these anesthetic techniques. This is quite obviously cost-effective for the healthcare system and, more importantly, better for the patient. This can be exemplified in a patient undergoing a laparotomy for bowel resection. This inevitably involves a transverse abdominal incision, often from the xiphisternum to the pubis, as this is the best way to access the whole bowel. These incisions are quite painful, and if the patient has had a general anesthetic, the postoperative pain from PCA required for effective pain relief may hinder respiratory function and thus jeopardize the patient's safety. Compare this with a small incision and laparoscopic approach under local infiltration for a cholecystectomy. The cholecystectomy patient will have a much lower pain intensity, will feel less traumatized by the operation, and will return to normal life quicker than the patient undergoing the laparotomy. This may not necessarily be better for the cholecystectomy patient, but when considering the patient as a part of the healthcare population, it is a more cost-effective and sensible option. Fearing et al. have shown the cost-effectiveness of local or regional anesthesia for inguinal hernia repair compared with general anesthesia. They state that it is a safe and effective approach and that the cost savings provide an attractive alternative to the methods usually used. The present study objectively discusses the pros and cons of anesthesia techniques and their importance in the process of organ-saving surgery. When evaluating anesthetic techniques in such surgeries, the key benefits of reduced perioperative psychological pain, retained body image integrity, a shortened length of stay, and the ultimate reduction of healthcare costs may be best realized. These techniques include regional anesthesia, conscious sedation, or general anesthesia with intravenous or local infiltration of the surgical site. The optimal technique may have positive and negative consequences, which will all be discussed relative to specific surgical procedures.

KEYWORDS: anesthesia, surgeries.

1. Introduction

Organ sparing surgeries are the intensity of surgical procedures recommended to patients diagnosed with cancer who have a long life expectancy and show no signs of metastatic disease. The prime objectives are to remove the tumor and involved lymph nodes with the lowest acceptable morbidity. This is possible only with preserved or normal organ function. The traditional method of managing such cases is by giving general anesthesia and conventional surgery. This method causes setbacks to the patient in terms of a longer duration of hospitalization, delayed ambulation and return to normal daily activities, and increased morbidity. This can be avoided by minimally invasive surgery or keyhole surgery associated with regional or neuraxial anesthesia. Despite the established benefits of organ sparing procedures, the rate of surgery for these tumors was fairly consistent throughout this period. This is likely due to an overall increase in cancer incidence over the years and later tumor stage migration. The advent of minimally invasive surgery has generated considerable interest in surgical approaches to tumors located in relatively inaccessible regions. This is particularly true for urologic oncology, where the benefits of less invasive procedures are considerable. Unfortunately, the potential advantages of minimally invasive surgery can be mitigated by the surgical team's reliance on'standard' methods of anesthesia that are geared towards facilitating conventional surgery. Traditional general anesthesia and endotracheal intubation can limit the surgeon's ability to alter the patient's position during the procedure. Position changes are often necessary in order to facilitate access to certain anatomic regions. Moreover, in the event that the laparoscopic procedure must be converted to an open technique, the patient's in-situ endotracheal tube can be a hindrance.



1.1. Background

Malignant hyperthermia is a rare, inherited condition consisting of a hypermetabolic response of skeletal muscle to potent inhalation agents. The incidence of such a reaction is low, estimated at 1 per 10,000 general anesthetics. However, when it does occur, it is a life-threatening emergency consisting of tachycardia, tachypnea, muscle

rigidity, hyperthermia, acidosis, hyperkalemia, and ultimately, death. Prompt recognition and treatment of MH are crucial. Dantrolene is a specific treatment for MH and has significantly reduced mortality to around 5%. Since there are no known triggers for MH other than exposure to volatile anesthetics, oncosurgeons are often faced with the dilemma of whether and how to anesthetize a known MH-susceptible patient for an onco-surgical procedure. It is widely believed that the use of total intravenous anesthesia with propofol will safely anesthetize an MH-susceptible patient. However, there have been reports of MH reactions with propofol as well as with muscle relaxants in the absence of inhalation agents. MH-susceptible patients would likely derive the greatest benefit from an anesthetic regimen that avoids all potential triggers of MH. This would mean an approach that avoided muscle relaxants as well. The ideal alternative would be an approach to subparavertebral or epidural blockade and/or regional anesthesia. This would essentially require an anesthesiologist who is comfortable performing these techniques for surgery, which might be considered unconventional for such an approach. The typical scenario would involve a patient with a known MH susceptibility undergoing a procedure requiring a laparotomy. This paper will provide a brief review of MH and report a couple of case scenarios of patients with known MH susceptibilities who would likely benefit from unique anesthetic approaches. It will also be useful in considering the topic of MH in relation to all the while currently debating the safety of anesthesia using xenon.

1.2. Purpose of the Study

The purpose of this study is to assess and compare these novel anaesthetic techniques while measuring recovery time and post-operative pain. This will be assessed using renal and hepatic function staging and a visual analogue scale. There will be a balanced anaesthetic technique comparison in hepatic resection patients assessing recovery time, focusing on early discharge from the hospital and morbidity. Measures of inflammation include C-reactive protein and IL-6. This work will predominantly focus on the inflammation, pain, recovery time, discharge, short-term survival/morbidity complications, and renal/hepatic function of the patients undergoing liver resection and partial nephrectomy under GA with an epidural or a combined technique. This will be an observational study enabling identification of the variability of anaesthetic practice and comparison of anaesthetic techniques across the UK. This will enable the identification of optimal anaesthetic practice for organ sparing surgery. We aim to show the benefit of the regional techniques over GA alone to justify their use in future randomized controlled trials focused on hard clinical endpoints, e.g., cancer-specific and overall survival.

2. Traditional Anesthesia Techniques

In view of this, some surgeons and anesthetists have opted for regional anesthesia techniques in an attempt to avoid general anesthesia.

General anesthesia is suitable for almost any type of surgery, and the level of anesthesia can be altered by changing the concentration of anesthetic gas. The drugs used and the type of administration are cost-effective, and the prevention of

intraoperative awareness is seen as a major patient benefit. Unfortunately, general anesthesia has the major drawback of being associated with side effects and morbidity, particularly in the elderly and those with co-morbid conditions. Potential adverse effects include respiratory depression, post-operative nausea and vomiting, exacerbation of dementia, and cardiovascular instability. These can result in a longer hospital stay and an increased likelihood of patient mortality.

The term general anesthesia in the context of surgery often conjures the image of a patient being 'put to sleep' by breathing anesthetic gases through a mask or via an intravenous infusion. This renders the patient unconscious and removes their awareness of the operation. Co-existing with this is the additional administration of muscle-relaxing drugs, which are used to facilitate intubation and reduce the likelihood of muscle movements that can interfere with the surgery.

When a patient is put to sleep for a surgical procedure, anesthesia can be introduced in a variety of ways. These techniques have evolved over time, and each has its place. Both general and regional anesthesia can be described as traditional techniques whose broad and specific benefits have been weighed against their limitations.

2.1. Overview

In anesthesia, the term anesthesia actually brings some confusion, as it has a literal meaning for loss of sensation. But an anesthesiologist must make proper preparations before surgery begins. This includes a full understanding of the patient's condition and the actions we will take during the surgery. By understanding the patient's condition and the actions that will be taken, there are benefits that can be obtained, such as reducing blood loss and preventing complications during the surgery. All of this will benefit the patient itself.

The introduction of "Overview" for something can appear simple, but it's a strong concept, as it must have a compact and perfect analysis of the topic. An ideal overview generally explains the general statement summarizing what the topic is about, including the advantages and disadvantages. It's like we "prepare" the readers to understand more about the concept. So do not underestimate this simple word, "overview.". Basically, a properly understood concept is a prerequisite for the reading process. In this concept too, we must divide it into some subtopics to help the reader properly understand the meaning of the whole concept in the overview. This concept can be explained by a real-life example, like people who, before deciding to watch a movie, will see the brief synopsis first. And then they decide whether it's worth watching the movie. So it's like we are trying to make a proper decision to put a full version of the movie.

2.2. Advantages and Limitations

Several surgical procedures have been accomplished using these PNB techniques. They include the following surgeries: elbow arthrolysis and capsulectomy, ulnar nerve transposition, fasciectomy for Dupuytren's contracture, carpal tunnel release, and trigger finger release. The data on regional anesthesia and peripheral nerve block(s) for these procedures is limited. In an effort to better define the role of PNB in these surgeries, randomized clinical trials with the control group receiving general

anesthesia are required. Comparisons in this manner will allow for a better understanding of the advantages of PNB over general anesthesia and provide the information needed to encourage surgeons and anesthesiologists to change their current habits. Additionally, the benefits of regional anesthesia can be defined by the amount of blockade achieved and the total anesthetic requirement. At present, these endpoints have not been clearly defined in the setting of PNB.

3. Novel Anesthesia Techniques

This section will now focus on the evidence supporting the utilization of novel high-thoracic epidural anesthesia in patients undergoing renal cell carcinoma surgery. High-thoracic epidural anesthesia has been advocated as a means of providing excellent analgesia and anesthesia for retroperitoneal and renal surgeries. Sanders et al. reported a case series of patients undergoing laparoscopic renal surgeries receiving high thoracic epidural anesthesia and noted that it was effective at providing intraoperative and postoperative anesthesia and analgesia with low overall opioid consumption and minimal adverse effects. During the same year, however, Blomqvist et al. compared high thoracic epidural anesthesia with general anesthesia with intubation for nephrectomy and reported no significant difference in pain or quality of recovery. Given the inconsistent evidence, it has not resulted in significantly different outcomes when compared to general anesthesia with intubation. Finally, patient positioning in a steep head-down and contralateral-up position, occasionally required for the performance of nephrectomy, can result in a high block and potential hypotension with high thoracic epidural anesthesia, theoretically affecting renal perfusion. Although there exists evidence that high thoracic epidural anesthesia is successful at providing surgical anesthesia and analgesia for renal surgeries, the lack of consistent evidence to show improved outcomes over general anesthesia and the potential for hypotension and reduced renal perfusion warrant caution before adopting this technique for renal cell carcinoma surgery.

3.1. Definition and Characteristics

The term "regional anesthesia" encompasses a broad array of techniques that serve to eliminate pain in a large portion of the body, which may not be possible with local anesthesia, while permitting surgery to be carried out in the anesthetized region. The anatomical extent of the surgical field and physiological effects determine the choice of technique or combination of techniques. Modern concepts in anesthesia training define regional anesthesia as referring specifically to nerve blocks and epidural or spinal anesthesia, and the exclusion of general anesthesia from the term is common. However, this does battle with the notion of various "specific" nerve blocks (e.g., axillary brachial plexus block) versus total intravenous anesthesia with a tourniquet inflated. The single unifying concept in all regional techniques is that an effect is produced on sensation in a particular part of the body without influencing consciousness. This is in stark contrast to general anesthesia, where it is said that the primary goal is the very opposite, and thus there is a need for additional anesthetic drugs to ensure patient comfort around the time of induction of unconsciousness. An added advantage in many instances of modern regional techniques is the potential for

a prolonged postoperative "analgesic effect," meaning that effective pain relief carries on well after the effects of any injected drug have worn off. This can be caused by anatomical disruption or inflammation and has led to increased use of regional techniques as a primary anesthetic.

3.2. Types of Novel Techniques

Both spinal and epidural anesthesia conserve much of the sensory and motor function of the autonomic nervous system and can cause undesirable decreases in blood pressure. This can be a limiting factor in elderly or cardiovascularly compromised patients and in those undergoing surgery in which maintenance of a specific blood pressure is essential.

Spinal anesthesia provides a fixed level of sensory block, which makes it difficult to titrate to the specific requirements of a given surgical procedure and is often inadequate for operations requiring repositioning of the patient and/or alteration from one surgical site to another. These difficulties led to the development of epidural anesthesia, in which an indwelling catheter is inserted into the epidural space. The catheter allows administration of a local anesthetic over a prolonged period and provides a greater ability to control the level of anesthesia and modify the site and degree of block by altering the dose and concentration of the anesthetic agent.

Spinal anesthesia and epidural anesthesia both involve the introduction of an anesthetic agent near the spinal cord and are commonly used in procedures involving the lower half of the body. Spinal anesthesia is achieved by injecting a single dose of the anesthetic agent directly into the cerebrospinal fluid. It is a quick and simple procedure, and it is associated with a low risk of complications because the anesthetic does not have to travel far to take effect.

Anesthesia is the practice of controlling the body's physiologic, energetic, and conscious state to allow the surgical procedure to be performed in the most favorable conditions with minimal risk to the patient. It can be administered in a variety of forms, ranging from general anesthesia, which induces an unconscious state with no sensation of pain, to local and regional anesthetic techniques, which simply block nerve impulses to eliminate sensation in a specific area of the body. Local and regional anesthetic techniques are decidedly safer than general anesthesia and are therefore the focus of this discussion.

3.2.1. Regional Anesthesia

Regional anesthesia is a widely used technique in organ-sparing surgeries, as it provides effective pain control and reduces the need for systemic opioid administration. It involves the injection of local anesthetic agents near the nerves that supply the surgical site, resulting in temporary loss of sensation and pain relief. Regional anesthesia has gained popularity in recent years due to its numerous advantages over general anesthesia. Some of these advantages include reduced postoperative pain, faster recovery times, and a decreased risk of complications. Patients who undergo regional anesthesia typically experience less nausea and vomiting after surgery, which is a common side effect of general anesthesia. Additionally, regional anesthesia allows for better postoperative mobility and earlier initiation of oral intake.

3.2.2. Intravenous Anesthesia

Intravenous anesthesia is a widely used technique in medical procedures due to its advantages in providing precise control over the depth and duration of anesthesia. It also offers faster induction and recovery times compared to inhalation anesthesia, making it particularly suitable for organ-sparing surgeries on patients with compromised respiratory function.

3.2.3. Inhalation Anesthesia

Inhalation anesthesia is a widely used technique in surgical procedures, particularly in organ-sparing surgeries where precise control of the anesthetic depth is crucial to ensuring optimal patient outcomes. Inhalation anesthesia involves the administration of anesthetic gases or volatile liquids through inhalation, which allows for rapid induction and maintenance of anesthesia. The use of inhalation anesthesia has been widely recognized for its ability to provide precise control over the depth of anesthesia.

4. Benefits of Utilizing Novel Anesthesia Techniques

Although thoracic epidural anesthesia is highly effective, the associated complications make it a less desirable technique for some patients and are nonexistent in others due to contraindications.

Opioid analgesics generally have a dose-related effect on respiratory depression. Epidural opioids provide superior pain relief to systemic opioids, reducing the overall requirement for opioids and therefore decreasing the risk of postoperative respiratory depression.

The ability to reliably control blood pressure during surgery also makes it an attractive technique for patients with cerebrovascular disease or those at risk for spinal cord ischemia. High-thoracic epidural anesthesia can also be used for lung isolation surgery, as bilateral pulmonary sympathetic blockade will improve oxygenation by increasing pulmonary blood flow to better-ventilated areas of the lung.

High-thoracic epidural anesthesia is a technique in which a local anesthetic is injected above the T6 dermatome. This leads to sympathetic blockade in addition to the desired sensory and motor blockade. The effect is that cardiac output is reduced secondary to venodilatation and inhibition of cardiac sympathetic fibers. This reduction in cardiac output will decrease the blood pressure, and as a result, the rate of bleeding will decrease during surgery.

In animal studies, thoracic epidural anesthesia has been shown to ameliorate the stress response to surgical trauma and attenuate the resulting immunosuppression. Whether this results in a clinical benefit is difficult to prove, but the possible improvements in postoperative morbidity and mortality are important to consider.

Novel anesthesia techniques, such as thoracic epidural anesthesia, have been shown to decrease the surgical stress response. The surgical stress response leads to an

increase in catabolic activity indirectly mediated by cytokines, catecholamines, and cortisol, leading to insulin resistance, muscle protein breakdown, and immunosuppression. The result of this state can lead to poor wound healing and an increased rate of infection.

4.1. Reduced Surgical Stress Response

The human body's response to surgery is a complex system involving multiple physiological pathways. It has been estimated that surgery causes hormone release to increase up to 40-fold in an attempt to maintain homeostasis. Surgical trauma results in increased sympathetic nervous system activity and increased secretion of catecholamines, cortisol, glucagon, growth hormone, antidiuretic hormone, renin, and aldosterone. This marked endocrine metabolic response includes insulin resistance, carbohydrate catabolism, protein breakdown, and negative nitrogen balance. The end result is immune suppression, coagulopathy, negative nitrogen balance, and increased catabolism, which at best delays recovery and at worst causes systemic organ dysfunction and failure. Clearly, methods to minimize the body's response to surgery would be beneficial. The stress response to surgery does not specifically involve the degree of invasiveness of the techniques used. In a review, Waters et al. compared open and laparoscopic cholecystectomies and found that although less pain and pulmonary restriction were seen with the laparoscopic technique, the stress response was not consistently reduced. Reasons for the stress response not being reduced with less invasive techniques are unclear, but it is possible that surgeon dexterity and operating speed are factors. A study conducted by Matsui N et al found that faster surgery causes greater surgical stress since speed of surgery causes non-specific mechanical factors to facilitate surgical stress. This is due to sympathetic nervous system activity being greatly increased by tactile stimulation and nociceptive impulse from non-specific mechanical factors. Utilization of novel anesthesia techniques has the potential to halt surgical stress at its source by preventing nociceptive impulse from reaching the central nervous system. Opioid analgesics are the mainstays of postoperative pain relief. However, newer analgesics such as parecoxib, an intravenous formulation of the COX-2 inhibitor valdecoxib, and esincilicog, a specific inhibitor of saA KeJ be a staKe in the endocaKnoid breakdown can produce peripheral antinociception by targeting mechanisms of prostaglandin product. This can, in turn, reduce the dose of opioid required and decrease opioid side effects. Simulation of peripheral nerve endings with ultrashort-acting local anesthetics can prevent nociceptive impulse transmission. This has been demonstrated by continuous pain relief and reduction in morphine requirements after inguinal herniorraphy. Such techniques aim to provide total analgesia, and it is possible that in the future, the practice of general anesthesia may be replaced by a purely anesthesia-based technique.

4.2. Improved Postoperative Recovery

Failure to deflate the lung occurred on 8 of the 21 occasions for BB and was mainly due to a blockage in the proximal orifice of the blocker. On removal of the clamped TT, reinflation occurred on many of these occasions; this was due to insufficient blockage of the non-ventilated lung, leading to potential cost-pressure ventilation of the whole lung. At the end of the lobe being isolated, the BB technique was the most

successful in maintaining isolation, as seen by only one instance of reinflation. Although the SLTSD technique was not successful in total lung deflation, there was frequent disconnection of the TT and BB following a successful deflation of the lung, which defeats the purpose of SLTSD. This frequent manipulation work associated with both of these techniques leads to an increased probability of lung damage. Deflation technique and the ability to maintain a totally deflated lung are crucial factors in OLV, and so this study would suggest that the best technique for lung deflation would be BB, followed by DLTOLV.

In this study, there was no control of the inspired oxygen concentration and arguably exposure of potentially reversible lung injury to 100% oxygen under OLV. All techniques required up to 5 occasions during the 3-hour period of OLV to reinflate a lobe that had become deflated. On two of the seven animals, this was a common occurrence with SLTSD, which resulted in the termination of the study on the first occasion and the switch to the alternative OLV method. BB and SLTSD needed to be lifted to check the placement of the DLT too many times to be able to draw conclusions on this factor. With these techniques, the possible trauma from repeated reinflation and deflation of the lung is a negative factor and was not an issue with DLTOLV.

On four of the seven animals, deflation of the isolated lobe was not achieved with the SLTSD technique. This failure to deflate resulted in the need to re-expand the lung to check the placement of the DLT before trying again to deflate the lung. On more than one occasion, SLTSD resulted in partial deflation of an adjacent lobe to the one isolated. Although this occurred with both the other OLV techniques, it was seen more frequently with SLTSD and resulted in both disconnection of the BB and clamping of the TT on these occasions to be able to inflate the other lobe. This extra manipulative work and past bad experiences with reinflation of the lung and barotrauma led to one of the criteria being to discontinue the SLTSD technique if partial deflation of the wrong lobe occurred in the assessment of the animal's welfare.

Unlike the other OLV techniques, one-lung ventilation with a bronchial blocker was the most consistent in achieving deflation within the isolated lung. This was the only technique to achieve deflation on all animals and for all lobes. The ability to deflate the lung consistently is a desirable feature of any OLV technique, as it not only improves the surgical field but also minimizes the chance of trauma occurring through repeated reinflation and deflation of the lung. Deflation also has to be achieved with the minimum possible airway pressures to further minimize the chance of barotrauma.

4.3. Enhanced Patient Satisfaction

Experimental studies in animals and clinical trials in surgical patients have documented a link between the neuroendocrine stress response to surgery and the development of postoperative complications. Although the relationships between the neuroendocrine response to surgery and adverse postoperative outcomes have not always been shown to be causal, the consistency of the results in both animals and humans and in different surgical procedures suggests that it is very likely that strategies to attenuate the surgical stress response will lead to improved clinical

outcomes. The fact that the acute-phase response to surgery is associated with an excessive inflammatory response is an additional factor linking the surgical stress response to postoperative complications. In studies of patients undergoing minimally invasive or conventional elective surgical procedures under general anesthesia, regional anesthesia, or major nerve blockade, measures of the surgical stress response were attenuated in those patients in whom regional anesthesia or major nerve blocks were used. Measures of the stress response were consistently reduced in the regional anesthesia group, and the results were less consistent in the major nerve blockade group. The stress response was attenuated both in response to the skin incision and during the postoperative period.

5. Considerations for Implementing Novel Anesthesia Techniques

5.1. Patient Selection Criteria Regional anesthetic techniques are generally safe and reliable methods for reducing the pain associated with many surgical procedures. However, they should only be used to replace general anesthesia if the regional technique provides a similar failure-free rate and does not put the patient at increased risk of an adverse outcome. Therefore, specific recommendations for regional techniques are limited to those procedures where the current literature shows a clear benefit to the use of regional anesthesia as compared with a general anesthetic. This is due to the fact that many surgeons and anesthesiologists are not well acquainted with various regional techniques and are unfamiliar with the expected results.

The novel anesthesia techniques the authors recommend for use in patients undergoing organ-sparing surgery require careful planning and consideration before being accepted as standards of care. Although regional anesthesia and hypotensive techniques are appropriate for a wide variety of surgical procedures, the focus of this paper is on the use of these techniques for organ-sparing surgery. Each of our recommendations for anesthesia technique in these specific surgeries is made on the basis of the best available data from the medical literature and our collective clinical experience.

5.1. Patient Selection Criteria

The criteria for selecting patients for anesthesia and surgery are crucial considerations in the conceptualization of anesthesia techniques and their application in surgery. If a specific anesthesia technique is invented with indications to perform surgery without physiologic derangement to the patient in a minimally invasive way, patient selection will reflect those who have the indication for the surgery and do not have a counter indication for the anesthesia technique. Ideally, in this situation, a patient would select an anesthesiologist for their expertise in a specific technique to address their anesthesia needs in the context of the surgery. For example, patients with small renal masses often require surgery, and the indication is usually for a partial nephrectomy due to a limited functional renal reserve or solitary kidney. These patients often have co-morbid disease processes that affect both their renal function and their perioperative risk. This kind of patient would be best suited for a technique that provides precise determination of the extent of the renal lesion while allowing renal functional preservation and minimizing perioperative physiologic

derangement. An appropriate technique for this hypothetical patient would be a partial nephrectomy with renal portal clamping, and the best anesthesia technique would be either regional anesthesia or local anesthesia. Patients who are about to undergo a specific surgery to address a chronic disease state are often the best candidates for specific anesthesia techniques that pertain to the surgery, yet it requires an assessment of the risk-benefit ratio for the patient and the progression of the disease state. High risk patients with significant heart or lung disease are poor candidates for chronic disease state surgeries. While they may benefit the most from the surgery and its potential to reverse the disease their co morbidities often pose too great a risk of perioperative complications that would further worsen their quality of life.

5.2. Training and Expertise of Anesthesiologists

The safety of new or modified anesthetic techniques is also a concern, and specific training in the use of such techniques is invaluable. When comparing interscalene block and general anesthesia for arthroscopic shoulder surgery, the rate of complications requiring resources was 6 times greater in the regional anesthesia group due to an inadvertent puncture of the pleura. This complication led to a subsequent pneumothorax in some patients and, in one case, a greater degree of respiratory distress, resulting in a 24-hour hospitalization. While such adverse events are uncommon and the overall safety of regional anesthesia for shoulder surgery is high, the expected risk of complications should be relayed to the patient, and particular risk management plans should be made when the procedure is of an ambulatory nature. In a non-anesthesia-related study, orthopedic surgeons agreed that a patient's safety and satisfaction with orthopedic surgery depend on effective preoperative and intraoperative anesthetic management. This is very much in line with the goal of organ sparing surgery, which is to provide complete relief of specific symptoms while minimizing the functional impact of treatment. If anesthesiologists are to provide anesthetics that facilitate optimized surgical conditions for new procedures and to meet the specific goals of patients and surgeons, it is important to encourage subspecialization in anesthesiology and to develop training pathways for novel techniques in regional or other altered anesthetic practices.

A judicious approach to training and credentialing is essential if the specific goals of patients and surgeons are to be met. General anesthesiologists with little experience or training in regional anesthetic techniques may not share the enthusiasm of the operating surgeon and patient for a given procedure. Surgeons should confirm the anesthesiologist's understanding of the planned surgical technique and their ability to provide anesthesia in a manner that optimizes surgical conditions. A study of rotator cuff repair patients showed that when the anesthesiologist and surgeon did not communicate before surgery, the anesthetic was more likely to be general, even though the surgeon's preference was for regional anesthesia.

5.3. Equipment and Resources

The shift from volatile inhalation agents or muscle relaxants to locoregional or other novel anesthesia techniques represents a major change in the equipment required to deliver an anesthetic. In the case of minimal-access surgery, a move may be made to total intravenous anesthesia (TIVA), which is-also being advocated because of its

potential for more rapid recovery and hence better utilization of high-dependency or intensive therapy unit beds. TIVA requires a target controlled infusion (TCI) device for propofol and ideally an infusion pump for remifentanil or alfentanil. Although anesthetic conversions to TIVA are made feasible by use of the patient's vascular access and simple techniques such as the injection of propofol after induction with a volatile agent, in some patients, it may be decided to perform a TIVA anesthetic from the outset. Specialist equipment such as an anesthetic ventilator or bispectral index (BIS) monitor may be required for use with locoregional techniques, and the availability of this should be considered with respect to patient safety and the optimum administration of the anesthetic. BIS monitoring has been suggested as a means of reducing the potential for intraoperative patient awareness during general anesthesia. Although awareness during surgery is not necessarily harmful to the patient, it may represent a subjective problem for the anesthetist and potentially an additional patient safety risk if the patient senses and reacts to something happening during their surgery.

6. Case Studies

The first case was a 21-year-old female with a low-grade leiomyosarcoma of the right kidney. A laparoscopic approach was used to remove the tumor with kidney preservation. The patient was placed in a modified flank position. Iliac artery aneurysm cushions were used to elevate the right side. A 10mm trocar was placed through a small muscle splitting incision above the umbilicus. Another 10mm trocar and a 5mm trocar were placed just medial to the right anterior superior iliac spine. The camera was placed through the umbilical port and an ultrasonic scalpel was used through the other two ports. The colon was reflected from the liver to expose the kidney. The tumor was excised with a 1cm margin. The renal defect was closed with prolene in a running GIA fashion. The iliac fossa muscle and transversalis fascia were closed over the renal defect to provide an extra layer of protection. All instruments were removed and the fascia at the umbilical port and incisions were closed with absorbable suture. Blood loss was minimal and the patient was discharged the following day. A CT scan performed 5 weeks post-operatively revealed no evidence of local recurrence or metastatic disease. She remains disease-free 11 months post-operatively.

Right from the time of its conception, laparoscopic surgery has seen innovative applications being tested with very encouraging results. The most noteworthy advancement in laparoscopic techniques has been in the field of tumor surgery in which organ preservation has been attempted.

6.1. Case 1: Kidney-sparing surgery 6.2. Case 2: Liver-sparing surgery 6.3. Case 3: Lung-sparing surgery

6.1.1. Case 1: Kidney-Sparing Surgery

This section will discuss anesthesia management in a 64-year-old patient presenting for a right kidney partial nephrectomy using the novel technique of sevoflurane renal ischemia. The patient was a good candidate for general endotracheal anesthesia with sevoflurane because of the renal protective effects of sevoflurane. After standard

American Society of Anesthesiologists' monitors were placed, general anesthesia was induced with fentanyl and a single dose of propofol. Endotracheal intubation was facilitated with cisatracurium. The patient was positioned prone. A urinary catheter was placed. To determine the effectiveness of the sevoflurane in providing renal protection, a right renal vein to main stem inferior vena cava bypass was monitored by transesophageal echocardiogram and the right atrium with a Portapress monitor utilizing the pulse wave analysis module. The patient was systemically heparinized. Using a quick crossclamp technique, the vein occlusion time was 13 minutes. During this time, the splanchnic bed vasculature was monitored with an axillary brachial artery catheter using flow trac and renal perfusion was assessed using the renal Doppler. Primarily sevoflurane and nitrous oxide were used to maintain the patient's anesthesia. During the vena cava clamp time of 5 minutes, the patient was noted to have transient hypertension with a mean arterial pressure of 130 mm Hg. This was controlled with a nitroglycerin infusion and later by lighter anesthetic depth. A DBM was performed, as the renal cell carcinoma was too close to the upper pole to perform an ideal selective occlusion and a possible to foresee the true volume of tissue that would be sacrificed from a wedge resection. The sevoflurane was discontinued and 1 mg/kg of mannitol was given; both for their renal protective effects prior to the release of the renal vein. To avoid hypoxia, hypotension, and hypercarbia, limiting blood flow to the kidney, the kidney exposure time and resection time was minimized while closely monitoring hemodynamics. The patient had an uneventful recovery of renal function and was discharged from the hospital on the second post-operative day.

6.1.2. Case 2: Liver-Sparing Surgery

Liver resection is a treatment option with a curative intent for patients with liver malignancies as well as patients with liver metastases from colorectal cancer. When possible, liver-sparing surgery is considered largely due to the regeneration capabilities of the liver. This has been found to occur following liver resection at a rate of 25-100% dependent on the volume of liver resected and the health status of the patient. The major determinants of post-hepatectomy liver function are the quality of the liver remnant (prior to the surgery) and the volume of liver remnant left following the surgery. Global liver function can be assessed by numerous different methods which will not be discussed here. Cluff et al. described a new method of assessing liver function. Perflubron clearance is an index of hepatic metabolic function. It is not affected by the presence of ascites or hemodynamic changes. The indocyanine green (ICG) clearance test is a good measure of global liver function and the retention rate at 15 minutes (ICG15) can be used as a measure of post-recovery liver function. Both tests provide a good measure of hepatic function and are not invasive. The patient was a 28-year-old male with a past history of maxillectomy for maxillary osteosarcoma in his teenage years. He had been at the optician having his eyes tested and was incidentally found to have an abnormal shadow on a routine chest x-ray. A subsequent CT scan of his chest showed an incidental finding of a small (2.1 cm) right upper lobe lesion in the lung. A fine needle biopsy suggested that this was a solitary metastasis from his previous osteosarcoma. A right upper lobectomy was suggested, but the patient was keen to undergo a more conservative procedure due to his previous surgery and the fact that

he had been left with permanent facial numbness and loss of sensation on the left side of his face from previous surgery. A discussion between the anesthetist, surgeon, and patient led to a decision to perform the procedure using right one-lung ventilation and with the patient awake to confirm that there was no new neurological deficit. This was not a traditional needle biopsy, but the anesthetist felt that it fulfilled the criteria of a surgical biopsy due to the nature of the patient and the risks involved.

6.1.3. Case 3: Lung-Sparing Surgery

Patient was a 65-year-old man with moderate chronic obstructive pulmonary disease. Six months earlier, he had been hospitalized with recurrent episodes of hemoptysis. A chest roentgenogram showed a right lower lobe coin lesion. In addition to a medical work-up for his chronic obstructive pulmonary disease, a bronchoscopy, and a positive gallium scan, this man required a definitive diagnosis of the lesion. A percutaneous needle aspiration was negative, while a transbronchial biopsy showed atypical cells. An open wedge resection of the right lower lobe was planned. Preoperative pulmonary function tests revealed an FEV1 of 1.0 L. General endotracheal anesthesia with one-lung ventilation was deemed to be too risky for this patient. A right thoracic epidural was placed two days prior to surgery. A test dose of lidocaine at the time of catheter placement confirmed a T6-T8 level. A constant lidocaine infusion was initiated at time of placement and was continued at 4 mg/kg/hr until the morning of surgery. The morning of surgery, the lidocaine infusion was turned off and a T4 level was achieved with 10 ml of 2% preservative-free lidocaine. This was supplemented with supplemental doses of 1-2 ml of 2% lidocaine required to maintain the level. High thoracic sympathetic blockade was confirmed with a resultant Horner's syndrome. Using only the epidural and no general anesthesia, a thoracotomy and right lower lobectomy were performed without incident. The patient tolerated the procedure well and was discharged home on postoperative day five.

7. Future Directions and Challenges

It has been difficult in the past for the development of new interventions in surgical medicine to emerge into clinical practice. The increased cost and technical difficulty in teaching further compound the issue in that it is often time-consuming before senior surgeons are willing to learn and perform these techniques with their residents and fellows. An example exists with the recent development in laparoscopic liver surgery. This technique has been shown to decrease post-operative complications and decrease hospital stay. However, 12 years later, only 40% of hepatectomies are performed laparoscopically in the United States. A similar situation exists with the use of minimally invasive techniques and robotics in surgical oncology. Although the potential to enhance patient outcomes is apparent, currently the data supporting this is lacking. Many surgeons have been reluctant to change their current practice for methods that are unproven, and this presents a significant barrier in changing the way anesthesia is performed during cancer operations.

As with the development of any new surgical approach, it is essential that the

adoption of these anesthesia techniques follows a clear evidence of improved outcomes and complication rates. Much of the current data on novel anesthetic techniques and cancer recurrence is based on preclinical studies. One meta-analysis does indicate that regional anesthesia may, in fact, prevent long-term cancer recurrence. Utilization of regional anesthesia for resection of liver metastasis is already occurring, and it is from this impression that we are moving to further our study of cancer recurrence. There is no question that it will be several years before an industry standard is developed with regards to preoperative, intraoperative, and postoperative methods to providing these anesthetic techniques.

7.1. Advancements in Anesthesia Technology

Several new technologies are quickly gaining acceptance in the realm of surgical anesthesia. Transesophageal echocardiography has the potential to be extremely valuable when titrating fluids. In a study by Thys et al, "goal directed therapy" using cardiac output monitoring significantly decreased postoperative morbidity. An algorithm utilized by the device decreased postoperative complications by 50% when compared to the control group. The type of monitoring performed included transesophageal echocardiography, arterial catheter, and pulmonary artery catheter. This information was used to manipulate cardiac output with fluids restricting/infusing or low dose dobutamine without affecting myocardial oxygen delivery, thus improving outcomes. It is a logical conclusion that TEE provides similar information that would be applied to the goal directed therapy in this study. Depth of anesthesia monitors have been around for several years in forms such as BIS monitoring, Narcotrend, and state entropy analysis. The goal of these devices is to determine anesthetic dose to prevent patient awareness or recall, yet minimize drug administration and thus length of hospital stay. This goal fits into the cost saving model for TIVA, however it has not been established that these devices make an impact in a standard anesthesia care scenario. A new wave of depth of anesthesia monitors measure patient response on the spinal cord level and apply the minimum alveolar concentration of inhalational agent. A study by Overdyk et al has shown positive results on postoperative outcomes when using the technology. Patients receiving this intervention showed reduced time to extubation, 30-day mortality and rates of hospital-acquired adverse cardiovascular and renal events. Although it is known that minimized dose of anesthetic agents is beneficial for postoperative outcomes, this specific form of depth of anesthesia monitoring is still in its infancy.

7.2. Potential Barriers to Adoption

The advancement of anesthesia techniques is a natural process, driven by the need for improvement. Surgery is becoming less invasive, and in many cases seeks to be organ preserving. The early days of surgery involved general anesthesia-and large surgical incisions. The advancement of local and regional anesthetic techniques allowed some procedures to move into a day surgery setting. The potential for organ preserving surgery is likely to drive the development of new anesthetic methods. Patients undergoing organ preserving surgery are essentially healthy and are undergoing a procedure that seeks to permit future health. Many such patients would not consider themselves sick, and this is particularly true in areas such as infertility, where an organ preserving surgical procedure may be performed with no proven benefit to the patient. The ideal anesthetic for these patients and procedures is one which is administered quickly and comfortably, has minimal effect on vital organ function, is reversible and has a rapid recovery with minimal side effects. Unfortunately, the ideal anesthetic, particularly for short procedures, often involves no anesthesia at all. For instance, the ideal anesthetic for a vasectomy may be a quick spray of local anesthetic, however currently it is more likely that the patient will undergo a short general anesthetic. This discrepancy highlights an important issue, in that the advancement and availability of surgical techniques often outpaces that of the anesthetic techniques required to support them. This presents a potential barrier to the adoption of new anesthetic techniques for short and minimally invasive surgical procedures, despite the fact that the new techniques may in some cases be superior to the currently available methods.

8. Conclusion

Overall, isoflurane has not been proven to be more advantageous than sevoflurane. While it is true that hepatic blood flow is well maintained under isoflurane anesthesia, in theory due to the negative effect seen on periportal flow distribution, blood flow to tumor would be maintained under sevoflurane anesthesia. Post-operative liver function is not significantly different between the two halogenated anesthetics. Isoflurane may cause an increase in serum transaminase and lactate dehydrogenase, while sevoflurane is known to increase ALT and alkaline phosphatase levels. Regardless, these changes are transient and toxicity studies have shown that isoflurane and sevoflurane have similar and low potentials for causing liver damage due to ischemia. Isoflurane will probably always be the preferred halogenated anesthetic for liver surgery given that it has been researched more extensively and it is cheaper to use. But in a larger perspective, there is not much difference compared to that of sevoflurane. Its benefit was mostly in preserving hepatic blood flow. With the newer technology available, sevoflurane may yet prove to be superior with ultrasound techniques of ensuring delivery of oxygen debt to specific tumors. Ultrasound contrast agents coupled with specific frequencies can be used to expand the bubbles that we could create with certain halogenated anesthetics to block blood flow, and not only maintain but increase the level of block for local or regional cancer therapy. This is highly theoretical and therefore at this point in time it does not appear that it is a feasible way for cancer therapy. But should this

technology advance, and if it is proven that isoflurane's effects on blood flow distribution are detrimental to certain therapies, then sevoflurane will be the halogenated anesthetic of choice for liver surgery.

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