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Patient Controlled Regional Anaesthesia: A Comprehensive Review

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ABSTRACT

Under management of pain is common in day surgery patients. Most common surgeries (upper and lower limb) involve weak opioid agents, non-steroidal anti-inflammatory drugs (NSAIDs), and paracetamol which may not be sufficient to provide adequate pain relief. Therefore, for optimum pain management, Patient-controlled regional analgesia (PCRA) is commonly assumed to imply on-demand, intermittent, IV administration of opioids under patient control. PCRA is applicable for postoperative pain management after various surgical procedures. PCRA in children provides satisfactory postoperative pain relief following lower limb surgery. PCRA offers advantage over continuous regional anaesthesia (CRA) in terms of lower costs, risk of systemic toxicity while producing similarly adequate analgesia.

Keywords: Analgesia, patient-controlled, regional anaesthesia, pain.

INTRODUCTION

Patient-controlled regional analgesia (PCRA) is a widely accepted technique for orthopedic postoperative pain management. Studies have revealed that the preoperative intrabursal prilocaine with epi-nephrine post-operative subacromial administration of ropivacaine by PCRA-technique provide the most effective analgesia with no major side-effects. The free plasma concentrations of ropivacaine were far below toxic in studies.[1,2] Also, PCRA is most commonly used in the management of post-operative and post-injury pain. Additionally, PCRA has been found to be effective in the appropriate amelioration of the pain originating from sickle cell disease, injury from the burns, cancer and other painful conditions. In fact, in the management of postoperative pain after TKA, patient-controlled regional analgesia (PCRA) is one of the several recommended modalities.[3] In the current times, the patient are becoming more mobile in the recovery period post-surgery. Hence, it is important to integrate better PCRA techniques for complete solutions.[4] The main advantage of this technique is that patients control their own dosing. PCRA provides better matching of patient need with analgesia and avoids opioid overdose and side effects. This method of patient controlled regional analgesia (PCRA) has recently become popular and several studies have shown excellent results in the ambulatory setting.[5,6] PCRA provides patients with an opportunity to participate in their own care and to overcome the inherent pharmacokinetic and pharmacodynamic differences which exist among patients. In a general sense, patient-controlled regional analgesia (PCRA) refers to a process where patients can determine when and how much medication they receive, regardless of analgesic technique. Many medical device manufacturing companies are now offering PCRA-based solutions to exceed the expected safety, reliability and optimize the comfort required by medical staff and patient in Regional Analgesia. These advanced medical systems are "Ready to Connect" providing an instant access to the infusion information and pain history through the web for hospital and home care applications. One such company is the Micrel, which has launched 'RythmicTM Evolution range' that is composed of Optimized ambulatory design, with compact and light weight features. It is an integrated with prefilled bags, each with the active medical substance within the range of 50 to 500 ml. These new systems have long battery life and air-in-line eliminator. Moreover, they are colour coded systems having their standardized protocol library. There are wireless systems that enable clinicians, nurses and healthcare providers to remotely monitor the PCRA via digital means. These systems have potential to send SMS alerts to the personnel-in-charge. Additionally, PCRA can ensure safety and feasibility

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of patients outside the hospital. PCRA offers excellent postoperative analgesia at home. Elastomeric pumps facilitate PCRA and are precise with drug delivery and safe for epidural infusions.[7]
However, the term is more commonly used to describe a method of pain relief, which uses disposable or electronic infusion devices and allows patients to self-administer analgesic drugs, usually intravenous (I.V.) opioids, as required. PCRA may provide superior analgesia and patient satisfaction; however, it does at higher cost. Major part of the cost in PCRA includes the cost of purchasing the equipments, the drugs and other consumables. Hence, in a busy general hospital ward that is devoid of qualified and experienced nurses and healthcare practitioners, the use of PCRA is immensely helpful.[8]
Since this phenomenon is dependent on the patients' perspective, it is therefore affected by patient-related factors. Such factors include the age of the patient, the psychological condition of the patient, the concurrent disorders faced by the patient, the co-morbid conditions experienced by the patient, level of dependency on opiods. All these factors severely affect the safety and performance of PCA. Age of the patient is the most investigated factor that affects PCA, and, it is correctly reported that infants-to-adolescent age group and geriatric patients might be less likely to appropriately manage the successful conduct of PCA.[9] However, PCA should not be withheld simply on the basis of age. There have been instances where children as young as 4yr-old to frail patients in their late 90s have successfully used PCA.[10] Overall, it can be safely inferred that the successful use of PCA demands reasonable and normal cognitive function, and, patients suffering from pre-operative dementia or become confused post-operatively are not suitable candidates for PCA.

<u>Advantages of Patient-controlled regional analgesia (PCRA):</u>

1. PCRA enables low local anaesthetic consumption leading to theoretically diminished cost and toxicity.
2. In an elderly population, PCRA showed subsequent advantages over continuous regional analgesia i.e., a reduction of cost and toxicity of local anaesthetic, and over morphine patient-controlled analgesia,i.e., a reduction of nausea and pruritus.
3. Analgesia with PCRA is obtained at, approximately, half the dose of opiod used by other techniques for similar procedures
4. PCRA may help to reduce local anaesthetic doses by adjusting analgesia to demand.[11]

<u>Disadvantages of Patient-controlled regional analgesia (PCRA):</u>

1. Some region display slow onset of analgesia.
2. In some cases, the duration of analgesia is limited, and, therefore repeat procedure may be required.
3. Slow onset of analgesia when compared to continuous epidural analgesia.[12]

Patient-controlled analgesia is an alternative in the absence of epidural analgesia; however, the patients need to be closely monitored during the postoperative period with particular attention to sedation and pulse oximetry.[13] Ekin et al. demonstrated that patient-controlled regional anesthesia optimized functional recovery and pain relief in patients undergoing acromioplasty (ACP) in an ambulatory orthopedic setting.[14] The main focus of this review is to converge the available literature regarding the patient-controlled regional analgesia.

<u>Peripheral nerve blocks (PNBs):</u>

Peripheral nerve blocks are a type of regional anesthesia. The injection of anaesthetic is near the specific nerve or bundle of nerves to block sensations of pain from a specific area of the body. Nerve blocks usually last longer than local anesthesia. PNBs are most commonly used for surgery on the arms and hands, the legs and feet, or the face. Hence, they find application in surgical anesthesia for both postoperative and nonsurgical analgesia. Currently, there are two types of PNBs. Type one involves the single-shot that involves one-time injection in the patient. This regimen will secure of pain control for up to a single day after the surgery. Another type includes the continuous catheters approach.[15]
Peripheral nerve blocks (PNBs) possess many characteristics of the ideal outpatient anaesthetic.

1. They provide site-specific surgical anesthesia and minimize the need for general anesthesia (GA).
2. PNBs provide dense analgesia, thereby reducing the opioid requirements. This in turn reduces the opioid-related side effects. The addition of patient-controlled bolus doses further improves analgesia allowing a reduction of the basal rate and further allowing a reduction of opioids and their related side effects. Overall, this ensures a symptom-free patient whom can be discharged home in a timely manner.
3. PNBs can provide prolonged analgesia.[16]

<u>There are vast amount of differences between peripheral nerve blocks and central neuraxial blocks. Some of the differences are enlisted below:</u>

- PNBs allow for anaesthetisation of a specific target area.
- The side effects (weakness of extremities) due to use of PNBs are severely reduced.
- There is drastic reduction in the dosage of local anaesthetic.
- There is complete absence of risk for unintended spinal anesthetic.
- There is complete absence of risk for urinary retention
- PNBs can be employed in body locations (e.g., face and scalp) where central neuraxial block is not possible.[17,18]

Patient-controlled regional anaesthesia (PCRA) ensures continuous peripheral nerve blocks. They are accomplished by infusion or intermittent boluses of local anesthetic solutions. Ideal peripheral nerve blocks undertaken while PCRA would provide analgesia while minimizing sensory, motor, and proprioception deficits. Additionally, the desirable attributes involve desirable toxicity profile and cost efficacy. There are several factors that affect the patient controlled regional analgesia via connecting Pumps. They are enlisted as the precise position of catheter placement, the number and location of catheters, patient weight, and ambulatory versus inpatient status.[19]

Table 1: List of published literature with Patient-controlled analgesia

SN	Title of Literature	Author	Year of publication	Setting
1	Patient-controlled analgesia for total joint arthroplasty.	Crawford and Malkani[20]	2007	General
2	Patient-controlled postoperative analgesia in orthopedic surgery: epidural PCA versus intravenous PCA	Bertini, Tagariello, Molino, Posteraro, Mancini, Rossignoli.[21]	1995	Orthopedic
3	Patient-controlled analgesia in orthopaedic procedures.	Scally, Berquist, Cochran.[22]	1988	Orthopedic
4	Patient-controlled analgesic for postoperative pain in orthopaedic patients.	Raj, Knarr, Runyon, Hobson.[23]	1987	Orthopedic
5	Efficacy of patient-controlled versus conventional analgesia for postoperative pain.	Bollish S, Collins CL, Kirking DM, Bartlett RH.[24]	1985	General
6	Patientcontrolled analgesia: a new concept of postoperative pain relief	Bennet RL et al.[25]	1982	General
7	Patient-controlled analgesia in trauma and postoperative patients	Baumann et al.[26]	1986	General
8	Patient-controlled analgesia following cesarean section: a comparison with epidural and intramuscular narcotics	Eisenach, J, Grice S, Dewan, M.[27]	1988	Gynecology
9	Epidural patient-controlled analgesia (PCA): an alternative to continuous epidural infusions.	Marlowe S, Engstrom R, White P.[28]	1989	General
10	Guidelines for the Management of Postoperative Pain after Total Knee Arthroplasty	Korean Knee Society.[3]	2012	Orthopedic
11	Patient-controlled analgesia in the management of postoperative pain	Momeni M, Crucitti M, De Kock M.[29]	2006	General
12	Patient Perspectives of Patient-Controlled Analgesia (PCA) and Methods for Improving Pain Control and Patient Satisfaction	Lance S et al.[30]	2013	General
13	Circadian variation of IV PCA use in patients after orthognathic surgery - a retrospective comparative study	Park S et al.[31]	2015	Orthopedic
14	Efficacy and safety of Postoperative Intravenous Parecoxib sodium Followed by ORal CElecoxib (PIPFORCE) post-total knee arthroplasty in patients with osteoarthritis: a study protocol for a multicentre, double-blind, parallel-group trial	Zhuang et al.[32]	2016	Orthopedic

Peripheral nerve blocks:

Peripheral nerve blocks of upper limb:

The surgeries of wrist and hand are the most commonly performed interventions by peripheral nerve block. Other blocks of upper limb include supraclavicular plexus block, infraclavicular plexus block, or the axillary block.

The supraclavicular block targets the trunks of the brachial plexus. The undergoing patient subject is requested to turn its head away from the area of functioning. Ultrasound enabled guidance helps to provide a circular view of the subclavian artery. The brachial plexus, found lateral and superior to the subclavian artery, appears as either three hypoechoic circles resembling a "stoplight" when more proximal or as a cluster of five to six smaller hypoechoic circles. An appropriate needle is to be advanced to reach out the target structures. Once in the desired position and appropriately confirmed by ultrasound imaging, the negative aspiration should be proceeded by injecting the desired volume of local anaesthetic, which spreads circumferentially around the nerve bundle, thereby giving the nerve bundle a floating appearance. The complications in the supraclavicular include the phrenic nerve paralysis and Horner syndrome.[33] The supraclavicular block has been described to be used in the form of disposable and inexpensive elastomeric pumps and allows day patients to self-administer local anesthetic at home after various surgical procedures. This technique is suitable for both hospital and out-patient setting.[34]

Infraclavicular: The infraclavicular block targets the divisions and cords of the brachial plexus and provides anesthesia for the hand, forearm, elbow, and upper arm.[35]

Axillary: The axillary block is performed at the level of the branches and is most useful for procedures involving the forearm. With the help of ultrasound sonography, the diagnostic probe is positioned in the patient's axilla. This will help to locate the axillary artery in a cross-sectional view. In the cross-sectional view, the axillary artery appears as a circle. In this regimen, the target nerves in the vicinity of the artery include the radial, median, and ulnar nerves. An appropriate needle is advanced to the target structures. Upon attaining the required position and confirmation from ultrasound sonography, the negative aspiration is used. This is followed by injecting the desired volume of local anesthetic.[36] In order to obtain an entire block positioned distal to the elbow, the musculocutaneous nerve, located in the belly of the coracobrachialis muscle, must be in the targeted zone too. The axillary block improves the efficacy of PCRA. It is important to consider that the patients need to understand the home pump device. Also, patients need to be appropriately instructed about removal of the catheter at the end of treatment. The pump is designed to deliver the total volume within one hour; however, by closing and opening the clamp on demand. Thus it effectively functions as the patient-controlled regional anaesthesia device.[37]

Peripheral nerve blocks of lower limb:

Lumbar Paravertebral Block: Lumbar paravertebral block is typically accomplished through four to five injections of local anaesthetic alongside the lumbar paravertebral space. The technique consists of inserting block needle 2.5-cm lateral to the midline at T11 through L3 levels. Upon contacting the transverse process, the needle is “walked off” the process and advanced 1 cm deeper to inject 5 ml of local anaesthetic at each level. This results in layering of local anaesthetic within the lumbar paravertebral space and blockade of the lumbar plexus. The resulting block confers anesthesia to the groin, part of the hip and the knee, anterolateral and medial thigh and medial skin below the knee.[38] In Lumbar paravertebral block, PCRA is achieved by lightweight, portable drug infusion pumps allow ongoing intense analgesia for 24 to 72 hours but minimize opioid-related adverse effects. The use of PCRA in lumbar region requires appropriate patient selection, education, and planning to minimize the potential risks and to maximize the benefits of PCRA at home.[39]

Lumbar Plexus Block: Lumbar plexus block is another technique of anesthetizing lumbar plexus but through a single injection of larger volume of local anesthetic. The technique consists of inserting an insulated needle attached to a nerve stimulator 4 cm lateral the midline at L3/L4 level. Upon contacting the transverse process, the needle is “walked of” the process to elicit twitches of the quadriceps femoris muscle. Once the quadriceps twitches are obtained at approximately 0.5 mA, then around 30-35 ml of local anesthetic is injected with intermittent aspirations to prevent inadvertent intravascular injection. This results in layering of local anesthetic within the sheath of the psoas muscle and blockade of the entire lumbar plexus. The resulting block confers anesthesia to the hip, anterolateral and medial thigh and medial skin below the knee. When combined with sciatic block through the posterior approach, this technique confers anesthesia to the entire lower extremity.[40] The PCRA of lumbar plexus block is undertaken in adult patients, where the infusion rate is mainly limited by the type of infusion pump; and a rate of 0.2 mg/kg per hour is recommended for children.[41]

Ilioinguinal and Lateral Femoral Cutaneous Nerve of the Thigh Blocks: The blockade of specific, sensory components of lumbar plexus has a role of its own in clinical practice. For instance, ilioinguinal blocks provide effective analgesia after inguinal hernia repair. Femoral nerve block can occur after ilioinguinal field infiltration for inguinal herniorraphy. The mechanism could involve tracking of local anesthetic in the plane between the transversus abdominus muscle and the transversalis fascia laterally to the tissue plane deep to the iliacus fascia containing the femoral nerve. This has important implications, particularly in the day surgery environment and when long acting local anesthetics are used.[42] The patients’ need to be sensitized about the pump function i.e. how to turn on and turn off, how to protect the reservoir from sunlight, heat and water, and, checks for the signs of infusion. In summary, patient must be aware of pumps’ basal capabilities, pumps’ bolus abilities, disposability, temperature sensitivity and log-interrogation functions.

Femoral and 3-in-1 Nerve Block: Femoral nerve block confers anesthesia in the anterolateral thigh and the medial skin below the knee. A precise location of the femoral nerve using the advantage of a very predictable relationship of the femoral nerve to the femoral artery at the inguinal (femoral) crease level was reported to result in a 100% success rate for surgical anesthesia using a nerve stimulator technique. The key to this high success rate appears to be insertion of the needle at the inguinal crease level and immediately adjacent to the lateral border of the femoral artery.[43] The PCRA pump in femoral nerve block can be filled with the local anaesthetic agent. They are also described as balloon or spring vacuum pumps. The flow rate of the elastomeric pump is set by the diameter of the flow regulator. These are simple in design, relatively inexpensive, and easily explained to the patient. These pumps show significant increase in the infusion rate when the temperature at the flow regulators was increased. In addition, an increase or decrease in pump height can increase or decrease the infusion rate when elastomeric pumps are used.[44]

Sciatic Nerve Block: Sciatic nerve block is time-proven technique to provide analgesia and anesthesia of the lower extremity. The anterior approach to the sciatic nerve block (ASB) has recently also received a significant attention as it has several important advantages over the posterior or lithotomy approaches.[45] The PCRA pump in Sciatic nerve block suffer from battery issue but it allow greater flexibility in programming infusion therapy. In spite of this benefit, many patients do not feel comfortable changing the pump setting can produce concentration-dependent reductions in nerve blood flow.[46]

Popliteal Block: The popliteal block or block of the sciatic nerve in the popliteal fossa is an excellent anesthetic choice for foot and ankle surgery. When used as a sole anesthetic in outpatients, popliteal block provides superb anesthesia and postoperative analgesia, allows the use of the calf tourniquet and it is devoid of systemic or local complications seen with general, spinal or epidural anesthesia. Recently, this technique has been significantly revised to provide better consistency and allow its use in patients who cannot assume the prone position.[47] In the PCRA pump of popliteal block the main factors to be considered are the expense of the home infusion pump and the local anesthetic agent for continuous infusion at home. The cost of pumps vary depending on the type of pump (electronic vs elastomeric), and the manufacturer.[48]

Peripheral nerve blocks: truncal blocks:

In truncal blocks, the regional anaesthesia technique is performed on the trunk. In recent years, the use of truncal blocks to provide abdominal analgesia has gained popularity. When used within a multimodal regimen, truncal blocks may provide similar analgesia when compared with other regional anesthetic techniques. The unique feature of the ultrasound-guided truncal blocks is that in all of these techniques, in contrast to peripheral nerve blocks, no nerve or plexus needs to be identified: Local anaesthesia (LA) is injected in a particular muscle plane, in which the injectate spreads and reaches the intended nerves. This simple mechanism has made delivery of nerve blocks easy and versatile. Transversus abdominis plane (TAP) block is the easiest to learn and most widely practised truncal block. There are three described approaches to TAP block: Posterior approach: Injection in the lumbar triangle of Petit. Usually employed in the landmark-based technique, Lateral approach: LA is injected in the neurovascular plane between the IOM and TAM with the ultrasound transducer (UST) placed transversely in the anterior axillary line, above the iliac crest. Oblique subcostal approach: Injection in the subcostal area; LA is injected between the posterior rectus sheath (PRS) and TAM. Oblique subcostal TAP (OSTAP) is also called upper TAP block.[49] The pumps involved in PCRA of truncal blocks exhibit both the positive-pressure (spring-powered and gas-pressure-powered), and negative-pressure (vacuum) pumps. These pumps have been shown to offer similar postoperative analgesia for fewer technical problems and lower costs.[50]

Peripheral nerve blocks: Facial plane blocks

Erector spinae plane blocks: Erector spinae plane block (ESPB) is a novel regional anesthesia technique used in postoperative pain and chronic neuropathic pain of the thoracoabdominal region. This interfascial plane block involves injection of a local anaesthetic in a plane preferably below the erector spinae muscle. This block is supposed to work at the origin of spinal nerves. Erector spinae plane blocks have emerged as an effective and safe analgesic regional technique. It has a wide variety of applications ranging from control of acute postoperative pain to chronic pain. This block can be performed by superficial or deep needle approach. In superficial needle approach technique, drug is injected between rhomboid major muscle and erector spinae muscle, whereas in the deep needle approach, drug is injected below erector spinae muscle. Erector spinae plane blocks displays effective analgesia with less opioid requirements, along with simplicity and safety.[51]

TAP block: TAP block is called as transverse abdominis plane block. TAP block was first described in 2001 by Rafi as a traditional blind landmark technique using the lumbar triangle of Petit. This block provides access a number of abdominal wall nerves hence providing more widespread analgesia. Recently introduced ultrasound guided TAP block has been described with promises of better localization and deposition of the local anaesthetic with improved accuracy. The aim of a TAP block is to deposit local anaesthetic in the plane between the internal oblique and transversus abdominis muscles targeting the spinal nerves in this plane. The innervation to abdominal skin, muscles and parietal peritoneum will be interrupted. If surgery traverses the peritoneal cavity, dull visceral pain (from spasm or inflammation following surgical insult) will still be experienced. The block can be performed blind or using the ultrasound. The point of entry for the blind TAP block is the lumbar triangle of Petit. This is situated between the lower costal margin and iliac crest. It is bound anteriorly by the external oblique muscle and posteriorly by the latissmis dorsi. This technique relies on feeling double pops as the needle traverses the external oblique and internal oblique muscles. The ultrasound probe is placed in a transverse plane to the lateral abdominal wall in the midaxillary line, between the lower costal margin and iliac crest. The use of ultrasound allows for accurate deposition of the local anaesthetic in the correct neurovascular plane. This block is indicated for any lower abdominal surgery including appendectomy, hernia repair, caesarean section, abdominal hysterectomy and prostatectomy. Efficacy in laparoscopic surgery has also been demonstrated. Bilateral blocks can be given for midline incisions or laparoscopic surgery. A few complications have been reported with blind TAP block, the most significant of which was a case report of intrahepatic injection. Other complications include: intraperitoneal injection, bowel hematoma and transient femoral nerve palsy. Local anaesthetic toxicity could also occur due to the large volumes required to perform this block especially if it was done bilaterally. As with any regional technique, careful aspiration will help avoid intravascular injections. However, there have been no reported complications to date with the ultrasound guided technique.[52]

Rectus sheath blocks: The rectus sheath block is a useful technique for umbilical surgery, particularly in pediatric patients. Ultrasound guidance allows for a greater reliability in administering local anesthetic in the correct plane and decreasing the potential for complications. The placement of the needle is in the proximity to the peritoneum and the epigastric arteries. Guiding the needle under ultrasound guidance to the posterior rectus sheath rather than relying on 'pops' such as in the traditional, non-ultrasound techniques, makes this block more reproducible and reduces the risk of inadvertent peritoneal and vascular punctures. The rectus abdominis muscle is oval shaped, positioned under the superficial fascia of the abdomen. Blockade of the nerves of the rectus sheath results in anesthesia of the periumbilical area (spinal dermatomes 9, 10, and 11). Typically, this block is performed in the supine position. Since 2007, the technique has further developed to include ultrasound guidance and placement of rectus sheath catheters. Ultrasound guidance for regional anaesthesia is associated with higher block success rates, shorter onset times, reduced total anaesthetic dose required and reduced complications. There is also the advantage of direct observation of pattern of anaesthetic spread. Rectus sheath block will provide somatic pain relief for abdominal wall structures superficial to the peritoneum. Patients with rectus sheath catheters typically demonstrate low pain scores and low opiate requirements. Early mobility is a major advantage of the rectus sheath catheter technique. Rectus sheath block reliably provides sensory block for the whole midline of the abdomen. Compared to TAP block, the rectus sheath continuous catheter technique provides denser analgesia of a much shorter duration. Rectus sheath block does not provide analgesia for the lateral abdomen.[53]

PECS block: PECS block stand for Pectoralis nerve (Pecs) that constitute the newer ultrasound (US)-guided regional anaesthesia techniques of the thorax. This block was first described by Blanco in the year 2011. The PECS blocks are superficial thoracic wall blocks which through blockade of the pectoral and intercostal nerves can be used to provide analgesia for breast surgery and other procedures / surgery involving the anterior chest wall. These blocks are simple to perform, reduce postoperative analgesic requirements and avoid the use of more invasive techniques such as paravertebral blockade. PECS block has been performed as postoperative pain management and not as a primary anaesthesia in breast surgeries under general anesthesia (GA).[54]

SAP block: SAP block stands for Serratus Anterior Plane block. The Serratus Anterior Plane (SAP) Block is a relatively novel approach to providing regional anesthetic to the lateral hemithorax by blocking the lateral branches of the intercostal nerves. It is a suitable approach for analgesia in thoracic surgery, which provides analgesia at the level of T2-T9. In the SAP block, a local anesthetic agent is injected under or above the serratus muscle with US guidance and thus the lateral cutaneous branches of the ICN are blocked and paresthesia is provided in the dermatomes of T2 and T9. The block is expected to avoid autonomic blockade associated with TEA and the risk of serious complications involving the pleura and central neuraxial structures. Moreover, the sonoanatomy of SAPB is easy to identify, and the relatively shallow needle angle allows for easy block administration.[55]

QL block: This stands for quadratus lumborum (QL) block. QL block provides regional analgsia to the quadratus lumborum (QL) muscle that lies in the posterior abdominal wall dorsolateral to the psoas major muscle. The QL muscle originates from the posterior part of the iliac crest and the iliolumbar ligament and inserts on the 12th rib and the transverse processes of vertebrae L1–L5. The QL muscle assists in lateral flexion of the lumbar spine. Ultrasound-guided quadratus lumborum block is a recently described fascial plane block where local anesthetic is injected adjacent to the quadratus lumborum muscle with the goal of anesthetizing the thoracolumbar nerves. Clinical indications for QL blacks include Abdominal surgery either above or below the umbilicus. For QL blocks, the lateral decubitus position is preferred over the supine position as it provides better ergonomics and relevant sono-images of the neuraxial structures. Complications are related to the lack of anatomical understanding and needle expertise. It is possible to puncture intra-abdominal structures such as the kidney, liver, and spleen. QL blocks can provide somatic as well as visceral analgesia of both the abdominal wall and the lower segments of the thoracic wall and therefore could be a useful analgesic modality for selected abdominal surgeries. QL blocks may provide visceral analgesia due to their paravertebral and possibly epidural spread.[56]

The Superficial Trigeminal Nerve Blocks: For superficial trigeminal nerve blocks, the local anaesthetic solution should be injected in close proximity to the three individual terminal superficial branches of the trigeminal nerve divisions: frontal nerve (of the ophthalmic nerve, V1 division); infraorbital nerve (of the maxillary nerve, V2 division); and mental nerve (sensory terminal branch of the mandibular nerve, V3 division. Advantage: The sensory nerves can be blocked either at their emergence point from the cranium (V2 and V3) or, more distally and superficially, at their exit from the facial bones (V1, V2, V3). Disadvantage: Each nerve is anatomically close to its respective foramen, usually located on a line drawn sagittally through the pupil.[57]

Block of the Frontal Nerve (Supraorbital and Supratrochlear Branches): The block of the frontal nerve is useful for lower forehead and upper eyelid surgery such as repair of a laceration, frontal craniotomies, frontal ventriculoperitoneal shunt placement, Ommaya reservoir placement, and plastic surgical procedures, including excision of anterior scalp pigmented nevus, benign tumor with skin grafting, or dermoid cyst excision. Frequently, surgery on one side of the forehead requires a supplemental block of the contralateral supratrochlear nerve because of overlapping distributions of the nerves. Advantage: Block of branches of the ophthalmic nerve has been described for the management of acute migraine headache attacks localized to the ocular and retro-ocular region and in the treatment of pain related to acute herpes zoster. Disadvantage: hematoma, intravascular injection, and eye globe damage.[58]

Block of the Infraorbital Nerve: Infraorbital nerve block is commonly used in neonates, infants, and older children undergoing cleft lip repair to provide early postoperative analgesia without the potential risk of respiratory depression that may occur when opioid analgesics are used. Advantage: The other main indications are surgeries of the lower eyelid, the upper lip, the median cheek, endoscopic sinus surgery, rhinoplasty or nasal septal repair, and transsphenoidal hypophysectomy. Disadvantage: Hematoma formation, persistent paresthesia of the upper lip, prolonged numbness of the upper lip, and intravascular placement are possible.[59]

Block of the Mental Nerve: Procedures involving hemangiomata, laceration repair, and other surgery involving the lower lip, skin of the chin, and the incisive and canine teeth. Advantage: Less commonly, penetration of the foramen occurs. Disadvantage: Hematoma formation and persistent paresthesia have been reported. This may result in permanent nerve damage or vascular injection.[60]

The Maxillary Nerve Block: This block is mainly offered as an adjunct to general anesthesia for major cancer surgery of the maxilla, the ethmoidal sinus, and the pterigomaxillary or infratemporal fossa. In children, bilateral maxillary nerve blocks improve perioperative analgesia and favor the early resumption of feeding following repair of congenital cleft palate. Advantages: Many other procedures may benefit from a maxillary nerve block, such as maxillary trauma (Lefort I), maxillary osteotomy, or the diagnostic and therapeutic management of trigeminal neuralgias. Disadvantages: Block failure can occur due to inadequate bony landmarks or inadequate needle tip position external to the pterygomaxillary fossa. Complications include cephalgia, facial paralysis, trismus, and hematoma.[61]

The Mandibular Nerve Block: Mandibular nerve is blocked where the nerve emerges through the foramen ovale. Complete block results in anesthesia of the ipsilateral mandibular bone, lower teeth up to the midline, buccal and lingual hard and soft tissue, anterior two-thirds of the tongue, floor of the mouth, the external acoustic meatus and auricle of the ear in its anterior zone, the skin over the jaw, the posterior part of the cheek, and the temporal area (except the area of the angle of the mandible, which is supplied by the superficial cervical plexus). Advantages: Surgery on the lower lip, the mandible skin or bone (including the lower teeth), and the anterior two-thirds of the tongue can be accomplished with this technique. This block could be useful in patients with cancer or trauma. Nonmalignant chronic pain conditions such as trigeminal, vascular, or postherpetic neuralgia are also good indications for the mandibular block. Disadvantages: The risk of puncture of the internal maxillary or middle meningeal arteries can be high when the needle inserted too high in the space between the coronoid and condylar processes.[62]

Technique of patient controlled drug injection systems

The most common technique of patient controlled drug injection system include patient-controlled analgesia (PCA) pump. The PCA pump was developed in the late 1960s by Philip H. Sechzer. Basically, PCA is a computerized machine that releases a drug for pain at the press of a button. In most cases, PCA pumps supply opioid pain-controlling drugs such as morphine, fentanyl, and hydromorphone. The pump is attached to a thin, flexible tube, most commonly the intravenous line, which is placed in your vein. This medicine may be delivered either continuously (basal rate) or only when you press the button (bolus). PCA can be used in the hospital to ease pain after surgery. Alternatively, it can be used for painful conditions like pancreatitis or sickle cell disease. It also works well for people who can't take medicines by mouth. PCA can also be used at home by people who are in hospice or who have moderate to severe pain caused by cancer. Children as young as age seven can benefit from PCA if they understand the idea behind the PCA and can follow instructions. But people who are confused, disoriented, or unresponsive cannot use PCA.[63]

There are many kinds of PCA techniques:

1. **Intravenous PCA:** The pain medicine is delivered within the body through veins. Narcotics are the

most common analgesics administered through Intravenous PCA. Intravenous PCA can be used for both acute and chronic pain patients. It is commonly used for post-operative pain management, and for end-stage cancer patients.[64]

2. **Epidural PCA:** The pain medicine is delivered near the nerves of back. Patient-controlled epidural analgesia (PCEA) is a related term describing the patient-controlled administration of analgesic medicine in the epidural space, by way of intermittent boluses or infusion pumps. This can be used by women in labour, terminally ill cancer patients or to manage post-operative pain.[65]
3. **Inhaled PCA:** In 1968, Robert Wexler of Abbott Laboratories developed the Analgizer, a disposable inhaler that allowed the self-administration of methoxyflurane vapour in air for analgesia. The Analgizer consisted of a polyethylene cylinder 5 inches long and 1 inch in diameter with a one-inch long mouthpiece. The Analgizer was found to be safe, effective, and simple to administer in obstetric patients during childbirth, as well as for patients with bone fractures and joint dislocations.[66]
4. **Nasal PCA:** Patient Controlled Intranasal Analgesia (PCINA or Nasal PCA) refers to PCA devices in a Nasal spray form with inbuilt features to control the number of sprays that can be delivered in a fixed time period.[67]
5. **Transcutaneous PCA:** Transcutaneous delivery systems, including iontophoretic systems, are available. These are popular for administration of opioids such as fentanyl, or local anesthetics such as lidocaine. Iontocaine is one example of such a system.

Table 2: Side effects and complications of PCA pumps

SN	Intravenous PCA	Epidural PCA
1	Nausea	Weakness or heaviness in your legs
2	Vomiting	Vomiting
3	Sleepiness	Sleepiness
4	Slowed breathing	Slowed breathing
5	Itching, usually in several small areas on your body	Backache and Itching, usually in several small areas on your body
6	Trouble emptying your bladder	A mild drop in blood pressure

Patient controlled analgesia (PCA) in paediatric population: Patient controlled analgesia (PCA) is commonly used to provide analgesia following surgical procedures in the pediatric population. Today, PCA is common practice for managing acute pain of hospitalized children and adolescents in different contexts such as postoperative, oncology, trauma and palliative care Morphine and hydromorphone remain the most commonly used opioids for PCA. The use of PCA is currently the mainstay of acute pain management for children over the age of six years. Both, the morphine and hydromorphone are μ-opioid receptor agonists. Morphine is referred to as the "gold standard" for pain management.[68]

Patient controlled analgesia (PCA) in geriatric population: Very few studies have specifically evaluated the ability of elderly patients to use the Patient controlled analgesia (PCA) technology correctly.[69,70] Elderly patients frequently have more cognitive and physical impairments than younger patients, which may restrict their understanding of how to use the device, ability to remember directions for device use, and/or ability to physically use the device properly. In addition, they may be less accepting of new health technologies than younger individuals. Compounding these issues is that most teaching of how to use a PCA device occurs in the early hours after surgery, when hearing aids and glasses are not available for use and patients may not be alert enough to comprehend directions on device operation. The possibility of differences in pain perception or pain reporting with advancing age can also impact the outcome of the purpose.

List of different drugs used in PCRA:

1. Ropivacaine
2. Mepivacaine
3. Piritramide
4. Nalbuphine
5. Tramadol
6. Morphine
7. Buprenorphine,
8. Fentanyl,
9. Hydromorphone,
10. Meperidine,
11. Oxycodone
12. Alfentanil
13. Remifentanil
14. Ketamine
15. Naloxone
16. Bupivacaine
17. Pethidine and
18. Sufentanil

Figure 1: A conventional Patient controlled analgesia (PCA) pump

Figure 2: The Baxter PCA II Syringe Infusion Pump

CONCLUSION

Given the on-going popularity of patient-controlled regional anaesthesia, these observations are rarely surprising. This gives us the glimpse of the future where the analgesia can be completely 'on demand. Further, such on demand analgesia will be customized to the needs of individual patients. From the speed of recent studies in this field reveal that PCA could develop to be safer and more effective modality for pain management, and, it has the potential to completely overtake the conventional regimen of opiod analgesia.

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