REVIEW

The Relevance of Regional Anesthesia in Orthopaedic Surgery: Concepts and techniques.

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Abstract: Before the advent of anaesthesia in surgical practice, surgeons battled with patient's maximal co-operation during surgical procedures, management of pain intra-operatively and post-operatively. Anaesthesia has greatly aided in overcoming these challenges, but a sizable proportion of reduction in these challenges but approximately 30-80% of patients complain of moderate to severe pain post-operatively indicating that post-operative pain remains a problem. Controlled epidural anaesthesia and controlled peripheral nerve block which are types of regional anaesthesia provide superior pain relief during and after surgery, making regional anaesthesia of particular relevance in orthopaedic surgery. More so, general anaesthesia has some adverse effects on the outcome of operation and the patient. These adverse effects are rare but may be disastrous and life-threatening necessitating close supervision during and after general anaesthesia. Hence, the preference should be towards regional anaesthesia with regards to the choice of anaesthesia in orthopaedic surgery. This review aims to highlight some concepts and techniques on regional anaesthesia in orthopaedic surgery.

Keywords: Regional Anaesthesia, Sub-arachnoid block, Epidural Block, Orthopaedic surgery, Techniques.

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Receipt: 04/12/2019
Revised: 04/20/2019
Acceptance: 05/28/2019
Online: 05/28/2019

INTRODUCTION

Anaesthesia has greatly aided in overcoming challenges of pain and discomfort during surgery, but approximately 30-80% of patients complain of moderate to severe pain post-operatively *(Popping et al., 2008)* indicating that post-operative pain remains a problem. General anaesthesia is a state of controlled unconsciousness with deep hypnoses, analgesia and unresponsiveness *(ASA, 2004)*.

Regional anaesthesia is more site-specific and is typically divided into three categories based on the location of the injury. These are central neuraxial block, peripheral nerve block and field block *(Corning, 1884)*.

Regional anesthesia renders a larger area of the body insensate by blocking transmission of nerve impulses between a part of the body and spinal cord. Regional anaesthesia allows patients to undergo surgery and other procedures while being conscious without distress and pain that they would otherwise experience. *(Corning, 1884).*

REGIONAL ANAESTHETIC TECHNIQUES

Central neuraxial blockade involves injecting a local anaesthetic agent around the nerves of the central nervous system. Examples include spinal anaesthesia or sub-arachnoid anaesthesia and epidural anaesthesia *(Popping et al., 2008)*. Neuraxial anaesthesia with the use of short-acting local

Conflict of interests: None.

Ethics approval: Not required

Funding: None.

Authors' contributions: Both authors made substantial contributions in the literature search, literature review, write up and proof reading of the paper.

Acknowledgements: None.

doi: 10.32457/ijmss.2018.039.

anaesthetic agents like mepivacaine, 2-chloroprocaine permits rapid onset intra-thecal anaesthesia with early recovery profiles *(Abenstein et al., 2004; Corning, 1884)*.

The first planned spinal anaesthesia was administered in 1855 although in an animal by James Leonard Corning *(1855-1923)*, a neurologist in New York *(Corning 1885)*. He was experimenting with cocaine on the spinal nerves of a dog when he accidentally pierced the dura matter. Augustine Karl Gustav Bier was the first to perform spinal anaesthesia. He performed the first operation under spinal anaesthesia at the Royal Surgical Hospital of the University of Kiel *(1861-1949)* on August, 16th 1898 when he injected 3ml of 0.5% cocaine into a 34-year-old labourer *(Bier, 1899; Bier, 1908)*. The subject was scheduled to undergo segmental resection of his left ankle which was severely infected with tuberculosis, but he dreaded the prospect of general anaesthesia because he had suffered severe adverse effects during multiple previous operations. Therefore, Bier suggested cocainization of the spinal cord as an alternative. He injected 15mg of cocaine intrathecally which was sufficient to allow him to operate on the patient. The patient was fully conscious throughout the surgery but felt no pain. Two hours postoperatively, the patient complained of nausea vomiting, severe headache and pain in his back and ankle which improved the following day. He performed spinal anaesthetic injections on five more subjects for lower extremity surgery using a similar technique and achieved identical results *(Bier, 1899; Bier, 1908)*.. After using it on patients, he and his assistant each injected cocaine into the other's spine *(Corning, 1885)*. They recommended it for surgeries of legs but gave it up due to the toxicity of cocaine *(Bier, 1899; Bier, 1908; Corning, 1885; Gorelick & Zych, 1987)*.

Spinal anaesthesia is also called sub-arachnoid block. It is a form of regional anaesthesia involving the injection of local anaesthetic*(s)* into the subarachnoid space, generally using a fine needle, usually 9cm *(3.5 inches) (Corning, 1885; Gorelick & Zych, 1987)*. For extremely obese patients, some anaesthesiologists prefer spinal needles which are 12.7cm long *(5 inches) (Corning, 1885)*. The onset of action of analgesia in regional subarachnoid technique is about 5mins (Abenstein et al., 2004), hence quick onset of surgery and less waiting time.

In epidural anaesthesia a local anaesthetic agent is injected through a larger bore needle or catheter placed in the epidural space. The epidural space used for the injection of local anaesthetic agent*(s)* is larger than that in subarachnoid anaesthesia. Consequently, the injected volume used is more substantial, being about 10-20ml and sometimes up to 50 ml of the agents. An indwelling catheter may be placed that avails for additional or top-up injections later during surgery or for post-operative analgesia. The onset of analgesia is approximately 25-30mins *(Corning, 1885; Umapathy & Ayathullah, 2017; Waegerle, 1999)*. An epidural may be given at cervical, thoracic or lumbar sites.

Various methods can be used to administer epidural analgesia: single-injection, intermittent boluses, continuous infusion via an indwelling catheter with or without an infusion pump, or patient-controlled epidural analgesia *(PCEA)* where the patient self top up the anaesthetic agent based on pain and analgesic demand especially during the postoperative period *(Cook, 2000)*. Single-injection or intermittent epidural bolus requires the use of longer-acting opioids *(e.g., preservative-free morphine)* to achieve a longer duration of analgesia *(Bailey et al., 1993)*. However, the addition of morphine for such administration carries an increase in the risk of delayed-onset respiratory depression *(Bailey et al., 1993)*.

Continuous epidural infusion, on the other hand, offers the advantage of providing steady-state analgesia, especially when used in combination of short-acting opioids. This quality is a definite advantage when compared with single-injection administration or intermittent boluses *(Cook, 2000)*.

Patient-controlled epidural analgesia affords patients control over their pain management by allowing self-administration of boluses by way of a preset dose *(Yamaguchi et al., 1989)*. Patients, therefore, administer the dose on demand when their severity of pain increases. Since PCEA combines the benefits of continuous infusion with intermittent demand boluses, it is gaining favour in many institutions and amongst patients. *(Momeni et al., 2006; Available at: https://www.cancertherapyadvisor.com)*.

Occasionally sub-arachnoid and epidural blockade are combined for specific procedures to produce the benefit

of rapid onset of action and the prolonged and sustainable analgesia during surgery and the postoperative period. The combined spinal-epidural technique *(CSEA)* which is the intentional injection of a drug into the subarachnoid space and the placement of a catheter into the epidural space as part of the same procedure is becoming increasingly popular in recent years. The technique has the advantage that neuraxial block can be achieved rapidly using the spinal component while the epidural catheter can be used to prolong or modify the block. Such CSEA technique has been used for a wide variety of surgery in adults including orthopaedic, urological, vascular, gynaecological, general surgical and more commonly obstetric procedures. The technique has also been used for inguinal hernia repair in neonates *(Grabowska-Gaweł et al., 2003)*. Grabowska-Gaweł et al. *(2003)* investigated the efficacy of combined spinal-epidural anaesthesia *(CSEA)* that combines the main spinal and the supporting epidural anaesthesia for pain treatment after total knee replacement *(TKR)* and concluded that CSEA provides better pain relief for patients having knee joint replacement. This technique consequently leads to faster knee rehabilitation and therefore, eventually decreases the risk of postoperative cardiogenic complications, embolia and phlebothrombosis *(Grabowska-Gaweł et al., 2003)*. The technique shares similar complications of both sub-arachnoid block and epidural analgesia. Generally, spinal and epidural anaesthesia are of relevance in orthopaedic surgeries of the pelvis, femur, tibia and ankle *(Corning, 1885)*.

Peripheral anaesthetic techniques involves plexus block such as brachial plexus block and single nerve block. It involves the injection of the anaesthetic agent near the nerve or plexus supplying the area of operation *(Abenstein et al., 2004; Diz et al., 2002; Latifzai et al., 2008)*.

Brachial plexus block is the anaesthetic blockade of anterior rami of C5-T1 and a few fibres originating from C4 and T2 via the supra-clavicular or axillary approach *(Latifzai et al., 2008)*. This procedure is suitable for surgical procedures on the upper arm, and hand. This technique reduces the risk of exposure to general anaesthesia and its complications *(Latifzai et al., 2008)*.

In wrist block, selective abolishment of sensation in the areas of the hand which is innervated by the radial, ulnar and median nerves depending on the area in which the surgical procedure will be carried out *(ASA, 2004)*. Median and ulnar nerves can be blocked at the wrist at the level of the line connecting the radial and ulnar styloid processes with a fist formed, and the hand dorsiflexed at the wrist joint *(Latifzai et al., 2008)*. The radial nerve is blocked by subcutaneous infiltration on the dorsum of the hand between the radial styloid process and radial margin of the ulnar process. These blocks are used separately or in combination to achieve the desired anaesthesia for various procedures on the hand *(Latifzai et al., 2008)*.

Digital Nerve Block is achieved by injecting the local anaesthetic agent devoid of adrenaline at the base of both sides of the finger. This form of anaesthesia is relevant in operations of the fingers like suturing of lacerations and drainage of abscesses as in acute paronychia or felon *(Latifzai et al., 2008)*.

Intercoastal nerve block anesthesia of the intercoastal nerves is suitable for pain relief for fracture of the ribs and good pain relief enabling physiotherapy to be performed. It does not cause arterial hypotension though it may be associated with a high risk of pneumothorax *(Latifzai et al., 2008)*.

Tibial and Sural Nerve Block is suitable for analgesia for operations of the plantar surface of the foot *(Latifzai et al., 2008)*.

In the analgesia of dorsum of the foot, sensations subserved by the saphenous, superficial peroneal and deep peroneal nerves are inhibited. This technique is used for manipulation of fresh fractures of short, long bones of the foot, al though the degree of analgesia is unsatisfactory. There is the increased risk of massive absorption of toxic quantities of the anaesthetic agent into the systemic circulation *(Latifzai et al., 2008)*.

Intravenous regional anaesthesia involves the injection of the local anaesthetic agent into a peripheral vein of a limb which has been previously exsanguinated and excluded from central circulation by the use of two tourniquets *(Latifzai et al., 2008; Fagg, 1987)*. The volume of agent injected occupies the vascular compartment of the limb. Relaxation and dilatation of blood vessels produced by the agent cause enough of the agent to diffuse from the vascular compartment to block nerve endings in the area

marked for surgery. More extravasation of the agent occurs in traumatized areas of the limb than in normal limb. This aids analgesia, reduces blood loss and enables bloodless surgery due to the tourniquet. Risk of systemic toxication can occur if the proximal tourniquet loosens or is released or removed abruptly. This form of regional anaesthesia, otherwise called Bier's block, was introduced in 1908 by August Bier *(Corning, 1885; Fagg, 1987)*.

Intravenous regional anaesthesia in lower limb orthopaedic surgery has rarely been reported *(Fagg, 1987)*. In a prospective series of 50 orthopaedic procedures performed with prilocaine, over 90% of patients had excellent anaesthesia *(Fagg, 1987)*. These procedures are; Evans tenodesis, removal of loose body, excision of calcaneal spur. All these were ankle surgeries. In the foot; ganglion excision, bony bursae, and plantar fibroma can be done using this technique. In the hallux; 1st metatarsal arthrodesis and osteotomy, excision of metatarsal head, Kellers arthroplasty, removal of screws, excision of sesamoids. For the toes; proximal interphalangeal joint fusion, excision of exostosis of the hallux, and correction of varus of the 5th toe is all done with this technique *(Fagg, 1987)*.

Finally, field Block is achieved by the injection of anaesthetic agent into the adjacent tissues with subsequent diffusion into the surgical area. In orhopaedics, it is typically employed for minor procedures of the hand or foot *(Latifzai et al., 2008)*.

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