Section A-Research paper

An Overview about Caudal Block Anesthesia For Pediatric Population

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Article History: Received 10th June, Accepted 5th July, published online 10th July 2023

Abstract

Background: The physiology of pediatrics is characterized by a high metabolic rate, limited pulmonary, cardiac and thermoregulatory reserve, and decreased renal function. Multisystem immaturity creates important developmental differences in drug handling and response when compared to the older child or adult. Anesthetic management requires an understanding of the pharmacophysiologic limitations of the child as well as the pathophysiology of coexisting surgical disease. The physiological adaptation to extra uterine life of concern to anesthesiologist involve the respiratory and cardiovascular systems, central and autonomic nervous systems ,metabolism, thermal homeostasis, fluid and electrolyte balance, hemoglobin and the liver. Consequently, children were often under-medicated or not medicated at all for pain. This practice continued until the late 1980s, when changes began to occur in pain management in infants and children as a result of research, consumer demands, and legislation to promote development of drugs for these patients. Substantial evidence now indicates not only that children experience pain but that the pain experience may have long-term adverse consequences. Caudal analgesia is produced by injection of local anaesthetic into the caudal canal. This produces block of the sacral and lumbar nerve roots. It is useful as a supplement to general anaesthesia and for provision of postoperative analgesia. This technique is popular in paediatric patients. Catheter insertion may be performed for continuous caudal block. Caudal block is an easy, simple and safe anesthetic technique. It can be performed in subumbilical surgeries in children and infants, with a high success rate and a low incidence of complications or side effects. It can be concluded that so far, single-shot caudal block with local anesthetic has proved to be an appropriate and effective method for day-case surgeries, especially in pediatric patients.

Keywords: Caudal Block, Anesthesia, Pediatric Population

DOI: 10.53555/ecb/2023.12.Si12.291

The physiology of pediatrics is characterized by a high metabolic rate, limited pulmonary, cardiac and thermoregulatory reserve, and decreased renal function. Multisystem immaturity creates important developmental differences in drug handling and response when compared to the older child or adult. Anesthetic management requires an understanding of the pharmacophysiologic limitations of the child as well as the pathophysiology of coexisting surgical disease. The physiological adaptation to extra uterine life of concern to anesthesiologist involve the respiratory and cardiovascular systems, central and autonomic nervous systems ,metabolism, thermal homeostasis, fluid and electrolyte balance, hemoglobin and the liver **(1).**

Children are not small adults. Paediatric patients vary considerably and include the following groups:

Neonates: A baby within 44 weeks of age from the date of conception (<30 days of age).
Infants: 1 to 12 months of age
Child: 1 to 12 years
Adolescent: 13 to 16 years
The differences between paediatric and adult anaesthetic practice are reduced as the patients become older. The important anatomical and physiological differences will be considered below followed by a discussion of how these will affect anaesthetic practice**. (1).**

Pain in children:

Until the 1970s, pain in children was ignored in health care research. The common assumption was that children did not experience pain to the extent that adults do, because of the immature nervous system, or that children would not remember the pain **(2)**.

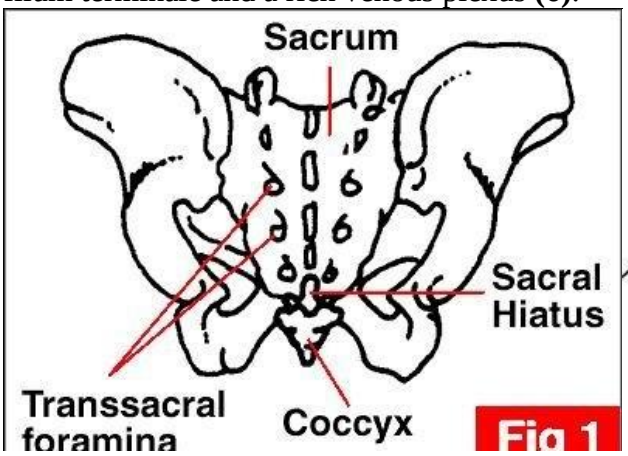
Consequently, children were often under-medicated or not medicated at all for pain. This practice continued until the late 1980s, when changes began to occur in pain management in infants and children as a result of research, consumer demands, and legislation to promote development of drugs for these patients. Substantial evidence now indicates not only that children experience pain but that the pain experience may have long-term adverse consequences.

The misperception that infants have immature nervous systems and therefore do not feel pain is still common. All nerve pathways necessary for pain transmission and perception are present and functioning by 24 weeks' gestation. Research in both animal models and human newborns confirms that a lack of analgesia for pain causes "rewiring" in the nerve pathways involved in the transmission of pain. Consequently, an infant or child who experiences pain once will have greater pain perception during later painful experiences **(3)**.

For example, Taddio et al found that babies who did not receive analgesia or anesthesia during circumcision later had greater behavioral and physiological disturbances during immunization **(4)**.

Further more, a lack of adequate postoperative analgesia in children can increase morbidity. In a study by **Anand et al., (5)**, compared with postoperative infants who received high-dose opioid analgesia, postoperative infants who did not had a significantly higher risk for death

The sacrum is a triangular bone that articulates with the fifth lumbar vertebra, the coccyx and the ilia. The dorsal roof consists of the fused laminae of the five sacral vertebrae and is convex dorsally. In the midline is a median crest which represents the sacral spinous processes. Lateral to this is the intermediate sacral crest with a row of four tubercles which represent the articular processes. The S5 process are remnants and form the cornua, which provide the main landmarks for indentifying the sacral hiatus. The hiatus is covered by the sacro-coccygeal membrane. The canal contains areolar connective tissue, fat, sacral nerves, lymphatics, the filum terminale and a rich venous plexus **(6)**.



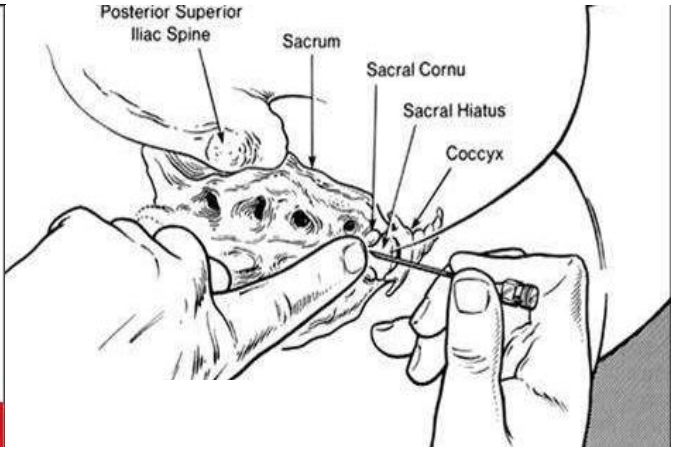


Figure (1): anatomy of sacrum.
Figure (2): The caudal epidural space is the lowest portion of the epidural system and is entered through the sacral hiatus. **(6)**.

The sacral canal is formed by the sacral vertebral foramina and is triangular in shape. It is a continuation of the lumbar spinal canal. Each lateral wall presents four intervertebral foramina, through which the canal is continuous with the pelvic and dorsal sacral foramina. The posterior sacral

foramina are smaller than their anterior counterparts. The sacral canal contains the cauda equina (including the filum terminale) and the spinal meninges. Near its midlevel (typically the middle one third of S2, but varying from the midpoint of S1 to the midpoint of S3) the subarachnoid and subdural spaces cease to exist, and the lower sacral spinal roots and filum terminale pierce the arachnoid and dura maters.

The lowest margin of the filum terminale emerges at the sacral hiatus and traverses the dorsal surface of the fifth sacral vertebra and the sacrococcygeal joint to reach the coccyx. The fifth spinal nerves also emerge through the hiatus medial to the sacral cornua. The sacral canal contains the epidural venous plexus, which generally terminates at S4, but which may continue more caudally. Most of these vessels are concentrated in the anteriolateral portion of the canal. The remainder of the sacral canal is filled with adipose tissue, which is subject to an age-related decrease in its density. This change may be responsible for the transition from the predictable spread of local anesthetics administered for caudal anesthesia in children to the limited and unpredictable segmental spread seen in adults.Considerable variability occurs in sacral hiatus anatomy among individuals of seemingly similar backgrounds, race, and stature. As individuals age, the overlying ligaments and the cornua thicken significantly. The hiatal margins often defy recognition by even skilled fingertips. The practical problems related to caudal anesthesia are mainly attributable to wide anatomic variations in size, shape, and orientation of the sacrum.The sacral foramina afford anatomic passages that permit the spread of injected solutions such as local anesthetics and adjuvants. The posterior sacral foramina are essentially sealed by the multifidus and sacrospinalis muscles, but the anterior foramina are unobstructed by muscles and ligaments, permitting ready progress of solutions through them.The sacral curvature also varies substantially. This variability tends to be more pronounced in males than in females. The clinical significance of this finding is that a noncurving epidural needle will more likely pass easily into the canal of females than males. The angle between the axis of the lumbar canal and the sacral canal varies between 7 and 70 degrees in subjects with marked lordosis. The clinical implication of this finding is that

the cephalad flow of caudally injected solutions may be more limited in lordotic patients with exaggerated lumbosacral angles than in those with flatter lumbosacral angles, in whom the axes of the lumbar and sacral canals are more closely aligned **(7)**.

Contents of sacral canal:

The terminal part of the dural sac, ending between S1 and S3. The five sacral nerves and coccygeal nerves making up the cauda equina. The sacral epidural veins generally end at S4, but may extend throughout the canal. They are at risk from catheter or needle puncture. The filum terminale is the final part of the spinal cord which does not contain nerves. This exits through the sacral hiatus and is attached to the back of the coccyx.

Epidural fat, the character of which changes from a loose texture in children to a more fibrous close-meshed texture in adults. It is this difference that gives rise to the predictability of caudal local anesthetic spread in children and its unpredictability in adults. The spinal cord reaches L3-4 in the neonate and the dural sac can be found at S3-4. Adult levels of L1 and S1 are usually reached by 1 year of age **(8)**.

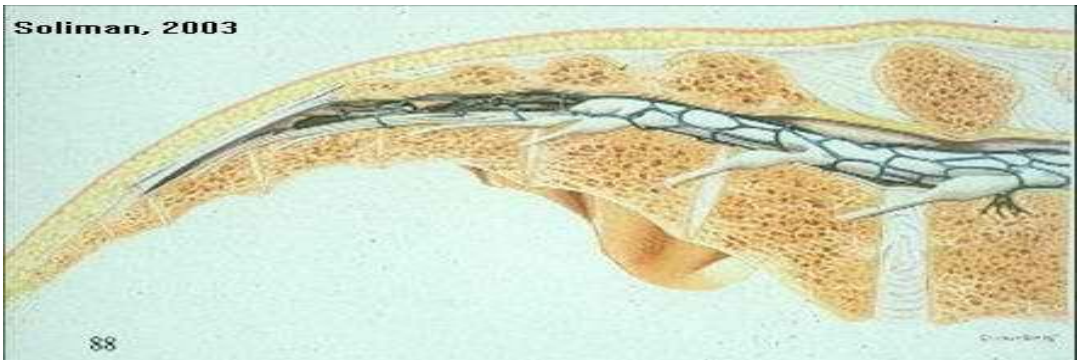


Figure (3): The sacrum is cartilaginous in infants and children which can allow for inadvertent intra-osseous injection **(9).**

Caudal analgesia is produced by injection of local anaesthetic into the caudal canal. This produces block of the sacral and lumbar nerve roots. It is useful as a supplement to general anaesthesia and for provision of postoperative analgesia. This technique is popular in paediatric patients. Catheter insertion may be performed for continuous caudal block **(6)**.

Caudal blocks are not common in adults. Sacral Hiatus is more difficult to identify and the caudal space is more difficult to enter with increasing age as the sacral bones begin to fuse**. (8)**.

Caudal block is an easy, simple and safe anesthetic technique. It can be performed in subumbilical surgeries in children and infants, with a high success rate and a low incidence of complications or side effects. It can be concluded that so far, single-shot caudal block with local anesthetic has proved to be an appropriate and effective method for day-case surgeries, especially in pediatric patients **(10)**.

Indications:

Caudal block is indicated in all types of surgery below the umbilicus whenever the area of surgery involves the sacral and lower lumbar nerve roots. The technique is suitable for:

Anal surgery (hemorrhoidectomy and anal dilatation)

Gynecologic procedures

Surgery on the penis or scrotum

Lower limb surgeries

Using a catheter technique, it is possible to use caudal epidural block in long surgical procedures. **(7)**.

The main goal of caudal block is to provide postoperative pain relief, and it is accepted that the block is performed in anesthetized children. However, some experts use caudal analgesia as the primary anesthetic technique in fully awake or in slightly sedated infants e.g., for inguinal hernia repair. **(11).**

Contraindications:

Coagulation disorders.

local or general infection.

Progressive neurological disorders.

patient or parental refusal apply to caudal anaethesia (CA).

Cutaneous anomalies (angioma, hair tuft, naevus or a dimple) near the puncture point

Spinal cord malformation such as a tethered cord.

(**12**).

Complications:

• **Dural tap.** This is more likely if the needle is advanced excessively in the sacral canal when subarachnoid injection of local anaesthetic agent may cause extensive spinal anaesthesia. Under general anaesthesia this should be suspected if non-reactive mydriasis (pupillary dilation) is observed.

• **Vascular or bone puncture** can lead to intravascular injection and consequently LA systemic toxicity. Preventative measures are use of a test

dose, cessation of injection if resistance is felt and slow injection under

hemodynamic and ECG monitoring. Sacral perforation can lead to pelvic organ damage (e.g. rectal puncture).
• **Exceeding the maximal allowed LA dose** risks overdose and related
cardiovascular or neurological complications.
• **Delayed respiratory depression** secondary to caudally injected opioid.
• **Urinary retention** - spontaneous micturition must be observed before hospital discharge.
• **Sacral osteomyelitis** is rare .
(**12**).

Technique:

The caudal epidural block was first introduced as a landmark-based, blind technique.With the advent of imaging technology, fluoroscopy and ultrasonography, have been increasing the successful rate of the technique. **(13)**.

Blind Caudal Epidural Block

The patient can be placed in prone or lateral decubitus position for blind caudal epidural block. A line is draw to connect the bilateral posterior superior iliac crests and used as one side of an equilateral triangle; then the location of the sacral hiatus should be approximated. By palpating the sacral cornua as 2 bony prominences, the sacral hiatus could be identified as a dimple in between. A needle is inserted at 45 degrees to the sacrum and redirected if the posterior surface of sacral bone is contacted. A subjective feeling of "give" or loss of resistance suggests piercing the SCL but is

associated with a miss rate up to 26% even in experienced hands **(13).**The "whoosh test," performed by auscultation at the thoracolumbar region with a stethoscope while injecting 2 mL of air, has a sensitivity of 80% and a specificity of 60% in adults**(14)**. Palpating for subcutaneous bulging on rapid injection of 5 mL air or saline had a positive
predictive value of 83% and a negative predictive value of 44%.The inaccuracy of using blind technique for caudal epidural injection in adults, even confirmed by various tests, is clearly evident**(14).**

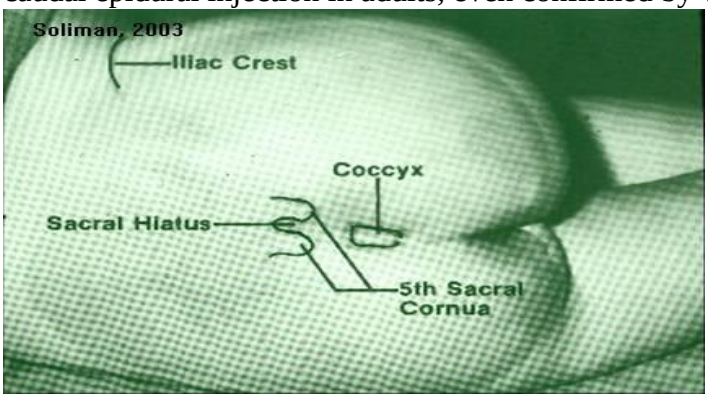


Figure (4) Anatomical landmarks in pediatrics

Fluoroscopy-Guided Caudal Epidural Block

Because of the inaccuracy of blind technique, some authors have recommended that caudal epidural injection is performed under fluoroscopic guidance **(13)**.The patient is usually placed in prone position for fluoroscopy-guided caudal epidural block. In lateral view of fluoroscopy, the sacral hiatus could be identified as an abrupt drop off at the end of S4 lamina **(13).** The block needle

trajectory can be visualized and navigated accordingly into the sacral canal. By injecting contrast medium under fluoroscopy, the placement of needle tip within the sacral epidural space can be verified, and intravascular or intrathecal needle tip placement can be detected. During caudal epidural injection, intravascular injection was reported in 3–14% of cases by conventional fluoroscopy even after negative aspiration.Fluoroscopy guidance has markedly improved the successful rate of caudal epidural block **(12).**

Ultrasound-Guided Caudal Epidural Block

The ultrasound-guided caudal block was first described by Klocke and colleagues in 2003 and has, since then, gained increasing popularity. Several studies from various populations have repeatedly reported very high successful rates (96.9–100%) of ultrasound-guided caudal injection**(15)** The patient can be placed in prone or lateral decubitus position. Usually, a 7–13 MHz, liner transducer will suffice for most caudal epidural injection; however, a 2–5 MHz, curved transducer may be needed in obese patients. The ultrasound transducer was first placed transversely at the midline to obtain the transverse view of sacral hiatus. The two sacral cornua appear as two hyperechoic structures(frog eye sign). Between the sacral cornua are two band-like hyperechoic structures; the superficial one is the sacro coccygeal ligament (SCL), and the deep one is the dorsal surface of sacral bone. The sacral hiatus was the hypoechoic region between the 2 band-like hyperechoic structures **(16)** At this level, the ultrasound transducer is rotated 90 degrees to obtain the longitudinal view of

sacral hiatus. Under longitudinal view, the block needle is inserted using the "in-plane" technique. The block needle can be visualized in real time, piercing the SCL, entering the sacral hiatus, but cannot be visualized beyond the apex of sacral hiatus. Therefore, without knowledge of dural sac termination from image study in advance, it is suggested that advancement of needle tip beyond the apex of sacral hiatus be limited to 5 mm to avoid dural puncture because the distance between the apex of sacral hiatus and dural sac termination can be as short as less than 6 mm **(16)**.

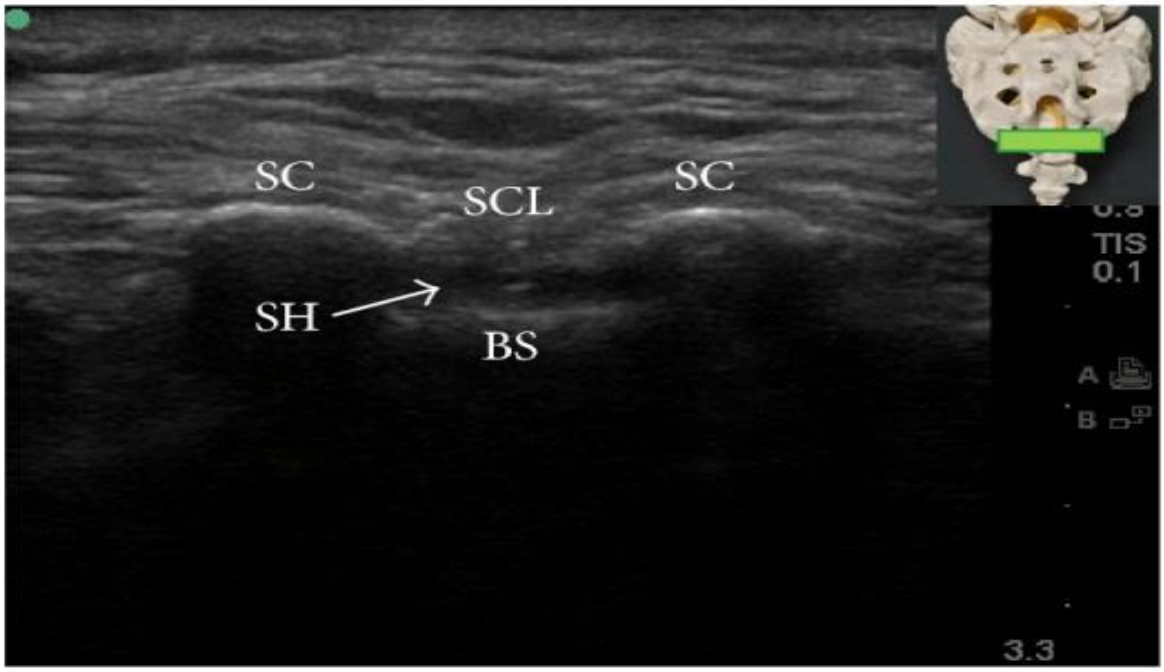


Figure (5)

Transverse ultrasound view of the sacral hiatus. The inset shows the position of the ultrasound transducer. BS: base of sacrum; SC: sacral cornua; SCL: sacrococcygeal ligament; SH: sacral hiatus.

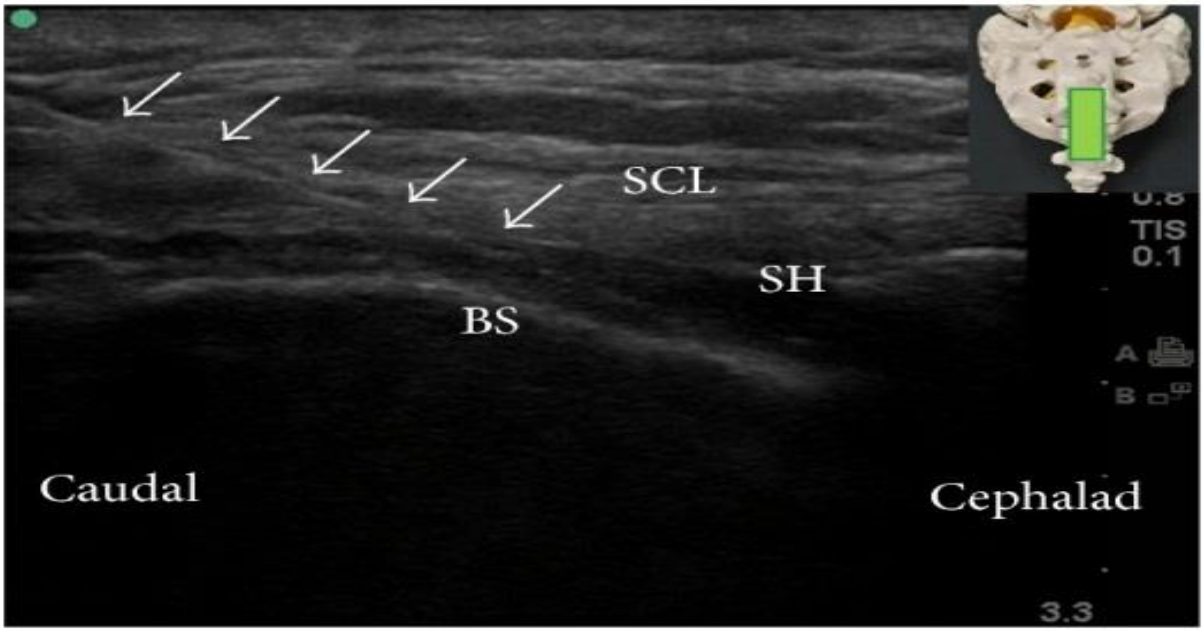


Figure (6):
Longitudinal ultrasound view of sacral hiatus. The inset shows the position of the ultrasound transducer. BS: base of sacrum; SCL: sacrococcygeal ligament; SH: sacral hiatus; arrows: needle

Choice of local anaesthetic:
Common drugs for caudal blockade are bupivacaine 0.125–0.25% and ropivacaine 0.1–0.375%, used at a volume of 0.5–1.5 ml kg−1 depending on the desired dermatomal level.Current guidelines recommend that doses should not exceed 2 mg ml−1 for ropivacaine and 2.5 mg ml−1 for bupivacaine, and the recommended volumes are 1.0 ml kg−1 when lumbosacral dermatomes, or 1.25 ml kg−1 when lower thoracic dermatomes are achieved **(17).**
Most common adjuvant drgus in caudal block are :
Selective alpha 2 agonists as clonidine and dexmedetomidine with recommended dose 1–2 μg kg−1 **(18)**
Dexmedetomidine:
It is a highly selective α_2 adrenoreceptor agonist that has been shown to have both sedative and analgesic effects. Compared with clonidine, which is an α_2 agonist that has been used for the treatment of hypertension, dexmedetomidine has an α_2: α_1 adrenoreceptor ratio of approximately 1600: 1 (seven to eight times higher than clonidine). This makes it primarily a sedative–anxiolytic. The elimination half-life of dexmedetomidine is 2 versus 8 hours for clonidine and the distribution half-life of dexmedetomidine is 6 minutes. It undergoes biotransformation in the liver, and the kidneys excrete about 95% of its metabolites **(19)**.
The usual dose of dexmedetomidine for procedural sedation is 1 ug/kg, followed by an infusion of 0.2 ug/kg/h. Its onset of action is less than 5 minutes and the peak effect occurs within 15 minutes. The pharmacologic effects of dexmedetomidine can be reversed by the α_2- receptor antagonist atipamezole **(20)**.
The mechanism of action of dexmedetomidine:
Direct :
Presynaptic and postsynaptic α_2 Adrenergic Receptors (α_2-ARs) are distributed over vital organs (heart, pancreas, kidneys), blood vessels and the central and the peripheral nervous system. Stimulation of postsynaptic α_2-ARs leads to hyperpolarization of neuronal membrane, whereas stimulation of presynaptic α_2-ARs reduces the release of norepinephrine. In the spinal cord, α_2-ARs are predominantly postsynaptic, and located in the dorsal horn.Activation of spinal α_2-ARs inhibits nociception, which most likely explains the analgesic properties of dexmedetomidine. Both presynaptic and
postsynaptic α_2-ARs are widely distributed in the brain, particularly in the pons and medulla.

The major site of noradrenergic innervation in the brain with the highest concentration of presynaptic α_2-ARs is the locus ceruleus, which is responsible for arousal, sleep, anxiety, and withdrawal symptoms from drug addiction **(23)**.

The hypnotic effect of dexmedetomidine is mediated by the hyperpolarization of noradrenergic neurons in the locus ceruleus. When the α_2 adrenergic receptor is activated, it inhibits adenylyl cyclase. This latter enzyme catalyzes the formation of cyclic AMP (cAMP), a crucial second messenger molecule that acts in many catabolic cell processes. By reducing the amount of cAMP in the cell, dexmedetomidine favors anabolic over catabolic pathways. Simultaneously, there is an efflux of potassium through calcium-activated potassium channels and an inhibition of calcium entry into calcium channels in nerve terminals. The change in membrane ion conductance leads to a hyperpolarization of the membrane, which suppresses neuronal firing in the locus ceruleus as well as activity in the ascending noradrenergic pathway **(21).**

Indirect action :

When a hypnotic dose of dexmedetomidine is administered, norepinephrine release from the locus ceruleus is inhibited. The absence of inhibitory control over the ventrolateral preoptic nucleus (VLPO) results in the release of g-aminobutyric acid (GABA) and galanin, which further inhibit the locus ceruleus and tuberomamillary nucleus (TMN) **(22)**.

CNS effects:

As mentioned before dexmedetomidine has a sedative, hypnotic, analgesic, and anxiolytic effects.Also it has an anesthetic and amnestic effects **(23)**.

It is a unique sedative agent. Although it produces sedative, analgesic, and anxiolytic effects, unlike other sedatives, it provides respiratory stability in that it does not cause ventilatory depression. It also has a neuroprotective effect because it decreases both CBF and CMRO2 as demonstrated by **(24)**.

CVS effects:

Dexmedetomidine has a biphasic cardiovascular effect. After administration of a 1 ug/kg bolus, there is a transient increase of the blood pressure in response to stimulation of the peripheral α_2-adrenoreceptors. Within 5–10 minutes, the blood pressure then decreases 10%– 20% as a result of inhibition of the central sympathetic outflow **(20)**.

It was reported that when dexmedetomidine is administered as a continuous infusion, it is associated with a predictable and stable hemodynamic response. However, care should be taken when administered to patients who are volume depleted, vasoconstricted, or have severe heart block as reported by **Hassan, (25)**, as dexmedetomidine can cause hypotension and bradycardia. Moreover, there was no evidence of cardiovascular rebound 24 hours after abrupt cessation of intravenous infusion **(24)**.

Dexmedetomidine has been used to provide sedation in a patient undergoing repetitive radiation therapy for a period of 30 days, with no evidence of tachyphylaxis **(26)**.

Moreover, **Shukry and Ramadhani ,(26)** have used dexmedetomidine to provide sedation in the postanesthesia care unit (PACU) following sevoflurane anesthesia to decrease the incidence of agitation in the pediatric population .Also, dexmedetomidine have been used by **Shukry et al. ,(27)** to allow intubation in a sedated pediatric patient.

Midazolam is short-acting hypnotic-sedative drug with anxiolytic, muscle relaxant, anticonvulsant, sedative, hypnotic, and amnesic properties. It belongs to a class of drugs called benzodiazepines. this drug is unique from others in this class due to its rapid onset of effect and short duration of action **(*28*)**.

Mechanism of action:

Midazolam has poor oral absorption and has an elimination half-life of 1.5 to 2.5 hours. Midazolam converts into its active metabolite alpha-1 hydroxy midazolam, which contributes to 10% of drug action. Midazolam metabolism occurs via hepatic CYP450 enzymes and glucuronide conjugation. The mechanism of action of midazolam indirect and is related to GABA accumulation and its affinity to the benzodiazepine receptors**.** Two separate receptors for GABA and benzodiazepine couple to a common chloride channel. It increases the frequency of chloride channel opening. Occupation of both the receptors cause membrane hyperpolarization

and neuronal inhibition. The anticonvulsant activity of midazolam is related to the excess GABA action on motor circuits in the brain ***(29*)**.

Midazolam acts on glycine receptors and produces a muscle-relaxing effect. Almost all the pharmacologic effects, including sedation, anxiolysis, anterograde amnesia, and anticonvulsant effect, can are explainable through its action on GABA receptors . Age-related deficits, hepatic, and renal insufficiency, also affect the pharmacokinetics of midazolam. Midazolam has both hydrophilic and lipophilic properties,depending upon the pH ***(30)*.**

Intravenous midazolam is used for the induction of anesthesia and also in the management of acute seizures. Because of its water-soluble nature, midazolam has a rapid onset of action and can be used to manage status epilepticus when intravenous administration of other medications is not feasible **(*31*).**

Midazolam has a high rate of tolerance, and the dose can be increased to maintain the therapeutic effect. Because of its easy mode of administration through the buccal and intranasal routes, it is a viable option in children to manage seizures. For its use in anesthesia, the response to the induction dose is more variable compared to thiopental.Midazolam can be used for anxiolysis and hypnosis during the maintenance phase of general anesthesia and is also superior to thiopental in the maintenance of anesthesia because of the less need for adjunct medications (***32*)**.

Midazolam is an adjunct medication to regional and local anesthesia for a wide range of diagnostic and therapeutic procedures and has greater patient and physician acceptance (***32*)**.

Contraindications:

Contraindications for the use of midazolam include acute angle-closure glaucoma, hypotension, and shock. Careful dose adjustment is necessary in cases of kidney and liver diseases, alcohol, and drug-dependent individuals.

Caution is necessary for pregnant individuals, children, and individuals with comorbid psychiatric conditions(***33*)**.

Administration in elderly individuals and acutely ill patients requires
caution to prevent the accumulation of active metabolites. Extra precautions should be taken in critically ill individuals as dose accumulation can occur **(*34*).**

Adverse effects:

The common adverse effects associated with midazolam use are hiccoughs, cough, nausea, and vomiting. Thrombophlebitis, thrombosis, and pain on injection are other adverse effects. The incidence of thrombophlebitis is less than with diazepam but similar to that of thiopental **(*35).***

Midazolam causes anterograde amnesia, drowsiness, ataxia, falls, and confusion in the elderly. Residual hangover effect can happen with nighttime administration of midazolam, which can impair the cognitive and psychomotor abilities, which can result in falls in elderly and impaired coordination during driving. Hypotension and tachycardia can occur with rapid intravenous administration. A higher dose can result in midazolam infusion syndrome and respiratory depression. Instances of midazolam infusion syndrome require continuous ventilator support. Paradoxical effects of midazolam are possible in individuals with a history of alcohol abuse and aggressive behavior, potentially leading to involuntary movements, verbalization, uncontrollable crying, and aggressive behavior. Respiratory depression can happen with a dose of 0.15 mg/kg, and the risk increases when used along with fentanyl. Concomitant use of midazolam with other CNS depressants can result in severe respiratory depression and death even at therapeutic doses ***(26).***

Long-term use of midazolam is associated with lasting memory deficits, which are only partially reversible after discontinuing the drug. For pregnant women, the administration of the drug in the third trimester causes benzodiazepine withdrawal syndrome in the neonate resulting in hypotonia, cyanosis, and apnoeic spells. Neonates may suffer from diarrhea, tremors, and hyperexcitability. About one-third of individuals receiving midazolam can suffer from tolerance after using the drug for four weeks. Withdrawal syndrome can occur if the dose tapers too rapidly. Symptoms due to the withdrawal of benzodiazepine include irritability, clonus, hypertonicity, nausea, vomiting, diarrhea, tachycardia, and hypertension. Sudden discontinuation of midazolam can result in status epilepticus **(*37*)**

Toxicity:

Toxicity with midazolam is rare but can happen when combined with other CNS depressants like alcohol, opioids, and other tricyclic antidepressants. The risk increases with intravenous administration and in elderly individuals with COPD. Symptoms of overdose include ataxia, nystagmus, hypotension, slurred speech, slurred speech, impaired motor coordination, coma, and death. Impaired reflexes, impaired balance and dizziness, dysarthria, and vasomotor collapse can also occur. Flumazenil is the antidote for midazolam toxicity **(*28*)**.

Supportive treatment is the initial therapy course. Activated charcoal is an option within 1 hour of intoxication. In many instances, flumazenil is not prudent, as it can precipitate seizures when used in a mixed overdose of CNS depressants. Rapid intravenous infusion in elderly individuals having COPD can also result in an overdose **(*38*).**

Midazolam an adjunct medication to regional and local anesthesia for a wide range of diagnostic and therapeutic procedures and has greater patient and physician acceptance with recommended dose 50μg kg−1**(*38*).**

Caudal block is an easy, simple and safe anesthetic technique. It can be performed in subumbilical surgeries in children and infants, with a high success rate and a low incidence of complications or side effects. It can be concluded that so far, single-shot caudal block with local anesthetic has proved to be an appropriate and effective method for day-case surgeries, especially in pediatric patients

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