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Reliable Routes For 100% Caudal Anesthesia in Adults.

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Abstract:
Background: The usefulness of the adult caudal anesthesia is worldwide acceptable in lower limb surgeries. Adult caudal anesthesia through the hiatus provides maximal hemodynamic stability with profound post-operative analgesia, although, anatomical distortion of the sacral hiatus in elderly persons handicapped this technique.
Aims: *The study is scheduled to find out ways to overcome the obstruction to get the access to sacral epidural space in adult life.*
Methods: *30 (thirty) elderly patients for lower limbs' surgeries were recruited for the study, and it was planned to attempt all patients for caudal anesthesia firstly through the sacral hiatus, next through the sacral foramens in previously unsuccessful cases and lastly through the drilling hole on the sacral hiatus in failed cases by previous two methods. The caudal anesthesia in all cases was administered by deposition of 25 ml of 0.5% ropivacaine with help of a nerve stimulator needle after local infiltration with 6 ml of 1% injection xylocaine.*
Results: *Only 5 cases out of 30 patients (16.6%) were successfully administered caudal anesthesia through the sacral hiatus. 20 patients out of 25 cases (80%) were successfully administered caudal anesthesia through dorsal foramen of sacrum. Lastly five patients out of 5 cases (100%) were successfully administered caudal anesthesia through drilling hole on sacral hiatus.*
Conclusion: *Caudal anesthesia is possible in 100% elderly patients either through sacral hiatus or through its dorsal foramen of sacrum or through the drilling hole over sacral hiatus. It is exclusively one of the best techniques of anesthesia for the lower limbs' surgeries.*
Key words: *Drilling holes, sacral hiatus, dorsal foramen, nerve stimulating needle, Sacral canal*

I. Introduction:

The motor and sensory activities of lower limbs depend on lumbosacral nerve roots of the spinal cord [L5 to S5]. The segmental block of these spinal roots [L5-S5] produces motor and sensory block of lower limbs. The sympathetic outflow, extending from tenth thoracic to second lumbar spinal segment [T10 to L2] are responsible for maintaining hemodynamic status of lower limbs. The segmental block of lumbosacral spinal nerve roots may be capable of producing the anesthesia of lower limbs for their projected surgeries from hip to toe.

Introduction of caudal anesthesia in 1901 by Sicard and Cathelin1 contributed the segmental block of lumbosacral spinal nerve roots in adults with hemodynamic stability during lower limbs' surgery. It became highly popular. But such popularity of caudal declined with the introduction of lumbar epidural in 1921 by Page and in 1927 by Dogliotti.[1]This declination was further enhanced by anatomical distortion of the sacral hiatus in adult life and absence of the sacral hiatus in 7.7% of population.2

Consequently, introduction of sacral spinal anesthesia3and sacral saddle block4 through its dorsal foramen promoted to introduce the sacral epidural5 through its dorsal foramen although, it is not appropriate to all cases with 100% success rate. Thereafter, introduction of caudal through the drilling hole on sacral hiatus with help of nerve stimulator needle6 solved all the problems in relation to adult caudal anesthesia. We designed our study to evaluate the advantages and disadvantages of caudal through its different ways like a) hiatus; b) foramen and c) drilling hole on hiatus.

II. Method:

We received the approval of Medical Ethical Review Board and written informed consent for procedure and study. We recruited 30(Thirty) patients, belonging to ASA class 1 and 11 for surgeries of lower limb under unilateral sacral epidural anesthesia.

All participants signed their consents after full explanation about the expected benefits and results, side effects and complications of the technique of sacral epidural through its dorsal foramens. Every participant was subjected to preoperative visit to exclude the contraindication of the proposed procedure.

In the O.T, peripheral infusion and non –invasive monitoring were started. Anatomical landmarks were identified. We identified the spinous process of fourth lumbar vertebra (L4) and tip of coccyx. Next, we located the mid-point of above two landmarks as third sacral vertebra (S3). The first sacral vertebra (S1) was located as mid-point of L4 and S3. The second sacral vertebra (S2) was found at the mid-point between S1 and

S3. The spinous processes of S1 and S2 are found approximately 2.5 cm apart, and their respective foramina lie 1.5 cm caudal and lateral to them. Similarly, S3 foramina lie 1.5 cm caudal and lateral to S3 vertebra.
After identification of S1, S2 and S3 foramina, aseptic preparation was done in the lateral position of patients.The patient was kept on the surgical side downward on the operation table, and selected foramens were infiltrated with 6ml of 1% injection lignocaine. We inserted the nerve stimulator need [13] (0.8 mm x 100 mm 21G Stimuplex A100 needle/ BBraun) through any of the three dorsal foramens selected beforehand. The needle was advanced perpendicularly like sacral spinal anesthesia [14, 15] until it contracted with bone. The depth of needle was noted from grazed nerve stimulator needle..The needle was withdrawn a little and again redirected 40 degrees to the foramen until it entered the foramen and crossed the intervertebral foramen evidenced with movement of great toe on the same side. Thus, we placed the needle correctly in the sacral epidural space. This was also further confirmed by loss of resistance and absence of cerebrospinal fluid (CSF) and blood in the needle. After confirmation of needle placement in sacral epidural space, 25 ml of 0.5% Ropivacaine was injected through the needle (2.5ml / segment of the vertebra) [17]. The patient was kept on the same position for another ten minutes and after which patient was turned to the supine position. Surgeons were allowed to operate after eliciting sensory block height suitable for proposed surgery. Another leg was examined to certain the involvement.

Heart rate, blood pressure, respiration, and oxygen concentration were recorded every three minutes for first ten minutes after which taken at every ten minutes interval. In the case of lower limb surgery upper level of sensory block was assessed by pinprick and motor block by modified Bromage scale which is as follows: 0 = lifting up extended leg, 1= flexed knee with full ankle movement, 2 =No knee movement, partial ankle movement, 3 = complete paralysis. We also recorded the onset time of sensory and motor block as the time gap between the epidural injection and bilateral loss of sensation and loss of motor activity of the lower limbs respectively. Similarly, we calculated the duration of the sensory and motor block and sent all collected data for statistical analysis using Graphpad Prism 5.

III. Result:

30 (Thirty) patients were attempted for caudal anesthesia at first through the sacral hiatus. Only 5 (five) patients out of 30 (16.33%) were successfully administered caudal anesthesia through sacral hiatus. The rest 25 (twenty-five) patients were tried for caudal through the dorsal foramens of sacrum. 20 (twenty) patients out of 25 (twenty-five) patients (80%) were successfully administered caudal through dorsal foramens of sacrum with help of nerve stimulator needle. Last 5 (five) patients out of five patients (100%) were successfully administered caudal anesthesia through drilling hole on the sacral hiatus with help of nerve stimulator needle. All cases of caudal anesthesia were conducted with nerve stimulator needle, and a contiflex catheter kept behind in the sacral epidural space. The sensory block extended to 12th thoracic dermatome to allow the lower limbs surgeries. Motor block of both limbs developed and continued further with the help of contiplex catheter. Local anesthetic was administered through this catheter to provide postoperative analgesia. No intravenous sedative or analgesic as adjuvants was used.

Thirty patients underwent orthopedic surgeries, including open reduction of hip, limb fracture, amputation and knee joint. All patients showed hemodynamic stability throughout the intraoperative period. Their hemodynamic profile is cited in table no 1. Similarly, demographic profile and nerve block profile are also placed in the table no 1.

All patients were followed for three days after operation. No patient developed sacral neuralgia, postdural puncture headache and incidence of visceral perforation.

IV. Discussion

The motor and sensory activities of lower limbs depend on lumbosacral roots of the spinal cord extending from first lumbar spinal segment to fifth sacral spinal segments (L1 to S5). Its sympathetic supply depends on neurones in the lateral horn of the lower three thoracic (T10, T11 and T12) and upper two lumbar (L1 L2) spinal cord segments. These sympathetic outflows are responsible to control the hemodynamic status of lower limbs. The limited cephalic extension up to the twelve thoracic spinal segments in the sacral epidural provides hemodynamic stability.

The segmental block of lumbosacral spinal nerve roots is capable of producing the lower limbs' anesthesia for projected surgery on lower limbs. The blocking of the lumbosacral segment, extending from L1 to S5 is an essential component for lower limbs surgery. The way to block the lumbosacral spinal nerve roots is comprehensively accepted as caudal anesthesia. It is an appropriate and accurate technique of anesthesia to provide anesthesia on the lower limbs with less involvement of sympathetic outflow for the same area.

Introduction of the first epidural anesthesia in 1901 by Sicard and Cathelin1 became popular as adult caudal anesthesia. Its usefulness as segmental block for lumbosacral spinal nerve roots is worldwide acceptable. But, such popularity of caudal declined with the introduction of lumbar epidural in 1921 by Page and in 1927 by

Dogliotti.1]. This declination was further enhanced by anatomical distortion of the sacral hiatus in adult life and absence of the sacral hiatus in 7.7% of population.2

Successful administration of caudal anesthesia is dependent on the presence of the sacral hiatus that is the end of the sacral canal and covered by sacrococcygeal ligament. Penetration of this ligament leads to sacral epidural space and successful administration of caudal anesthesia. Easy availability of sacral epidural space is associated with lower age group, but, with the advancement of age, anatomical distortion of the sacral hiatus leads to unsuccessful caudal anesthesia. The bony overgrowth over sacral hiatus along with soft tissue is the main cause of anatomical distortion of the sacral hiatus. The calcification of sacrococcygeal ligament and also obliteration of dorsal foramens of sacrum are frequently accompanied with the disease process of Ankylosis Spondylitis. Thus, penetration of the needle through the sacral hiatus becomes impossible.

Different variations of the sacral hiatus frequently mislead to detect the landmarks of the sacral hiatus and enhance the occurrences of failed caudal anesthesia. The longitudinal slit hiatus and second midline hiatus definitively offer difficulty to penetrate its' posterior wall. Transverse hiatus and large hiatus without cornua make difficult to locate the position. The transverse hiatus with absent coccyx and two prominent cornua, with two proximal 'decoy' hiatuses lateral two cornua abolishes its usual landmarks. Large midline defects in posterior sacral wall continuous with sacral hiatus and enlarged longitudinal hiatuses with overlying 'decoy' hiatus may lead needle insertion through the ligament, but not into the sacral canal. Anyhow, any abnormal form of the sacral hiatus grossly misleads the successful penetration of the needle to sacral canal. [1]

Subsequent introduction of lumbar epidural in 1921 by Page and in 1927 by Dogliotti appeared like a good alternative of caudal anesthesia. Later on, it became partially responsible for declination of initial popularity, gained by caudal just after its practical application. But, later on, lumbar epidural was criticized about its successful involvement of fifth lumbar and first sacral nerve roots. Owing to extensive cranial spread and less caudal spread [7], lumbar epidural is frequently incapable of contributing complete block of fifth lumbar (L5) and first sacral (S1) spinal segment [8] for their variable nerve size[9]. Such occurrence does not take place in caudal anesthesia, as local anesthetic, deposited in sacral epidural space, spreads only towards cephalad direction and avails enough scope to immerge the nerve roots within local anesthetic drug.

Recent introduction of sacral epidural anesthesia [5] through its dorsal foramens with the help of nerve stimulator needle is capable of bye-passing the anatomical distortion of the sacral hiatus and helps to achieve caudal anesthesia. The clinical manifestations of this technique are similar to caudal. But, in fact, this technique of sacral epidural is incapable of producing anesthesia to all cases. Obliteration of foramen due to deposition of calcium salt or conversion of foramen to the smaller size for the entrance of nerve stimulator needle is the cause of failure of caudal anesthesia through the dorsal foramen. Sizes of foramen are variable individual to individual. Some foramens may be smaller, or some may be bigger in size. The foramens of bigger size are good for the insertion of the needle.

Currently, surgical intervention to make access to sacral epidural space through the sacral hiatus confirms 100% success rate in administration of caudal anesthesia. With the help of an orthopedic surgeon, a hole is drilled on the sacral hiatus in cephalic direction. The sacral epidural space was identified with the help of a nerve stimulator needle, inserted through the drilling hole.

Surgical drilling procedure on the posterior wall of the sacral hiatus with 2.5 mm drill bit and adjustable guard, 2.5mm apart from its' tip is a simple and harmless technique. Usually, it does not cause any damage to any vital structure by an expert fellow. The sacral canal and adjustable guard prevent further progress of bit to drill the anterior wall of hiatus. The use of hand drill provides better control to stop the procedure when needed. The surgical intervention by drilling procedure on sacral hiatus is a good and harmless option to smash all obstructions offered by anatomical distortion of the sacral hiatus in the adult life.

The sacral hiatus is the defect in the lower part of posterior wall of sacrum and formed by failure of fusion or absence of the laminae of the S4 and S5 in the midline. The sacral hiatus is located at the caudal end of the median crest and is surrounded by the sacral cornua which are the remnants of inferior articular processes of 5th [S5] sacral vertebrae. They are free and prominent constituting an important landmark together with adjacent coccygeal cornua. This sacral hiatus is covered posteriorly by dense sacrococcygeal ligament that is formed from the supraspinatus and interspinous ligament, as well as the ligamentum flavum.

Penetration of this ligament by the needle provides the direct access to the caudal limit of the epidural space in the sacral canal. The sacral components of the sciatic nerve (S1to S3) exit through the respective intervertebral foramens bye-passing the sacral hiatus and escaping from drilling. 4th and 5th sacral spinal nerve roots, leaving dural sac at the level of S2 travel obliquely towards their respective foramens, located at 1.5 cm lateral from the midline remain uninjured at the time of drilling on the sacral hiatus. The less important structures like filum terminale and coccygeal nerve, travelling through the sacral hiatus to coccyx are on the verge of injury during drilling procedure by hand drill and such damage, if occurred at all, may be ignored causes negligible physiological alternation.

Sacral epidural space (SES) is continuous upwards as lumbar epidural space and below as sacral hiatus. Thus after deposition of local anesthetic in SES, reduced height of the cephalad flow of local anesthetic is more likely due to free leakage through patent dorsal and ventral openings of sacrum and large capacity of SES. The capacious sacral epidural space helps to explain the less involvement of the spinal segments of sympathetic outflow, responsible for hemodynamic status of the body.

The simplicity of the technique for perfect identification of the epidural space with the help of a nerve stimulator needle [6] is the acceptable procedure with less damage to surrounding structures. The evidence, produced by the stimulation of nerve by electric current, is an important guide to detect the epidural space in the presence of nerves. The deposition of local anesthetic in the epidural space after confirmation by nerve stimulating effect bears a better cephalad spread.

Problematic situation arises in anesthetic management of elderly patients owing to their limited organ reserve and coexisting compromised cardio-respiratory status. These groups of patients are frequently associated with hepatic and renal insufficiency. Hemodynamic instability during any surgical procedure is usually unwanted. Neuraxial block has definitive benefits to control the surgical stress response with reduction of blood loss during surgery. Caudal anesthesia is the better option providing better control over hemodynamic stability, surgical stress response and reduction of blood loss during the surgical procedures of lower limbs.

In this study, all participants are aged and scheduled for lower limbs' surgeries. All of them were administered caudal anesthesia either through sacral hiatus (16.6%) or dorsal foramens of sacrum (80%) or drilling hole on sacral hiatus (100%).[10] In short, all were operated under caudal anesthesia with hemodynamic stability. No adverse reaction like intravenous injection, intrathecal injection and total spinal postponed the procedure.

Complications of the caudal anesthesia are similar with those seen in the most of the other regional anesthesia. Meticulous attention with expertness is capable of decreasing the rate of complication. Claims of drug toxicity associated with the use of a large amount of local anesthetic failed to substantiate [11]. Nevertheless, potential danger exists with intravenous or intraossesous administration of the local anesthetic.[12] The chance of dural puncture is exceedingly rare as the termination of the dural sac usually occurs at the level of S2. The distance between the end of dural sac and apex of the sacral hiatus restricts the advancement of the needle not more than 1 to 2 cm.[13] The most frequent complications of caudal anesthesia include pain, infection and urinary retention. Among these, pain is the most common complication. It may be due to either soft tissue injury or periosteal hematoma. The periosteal pain lasts for several weeks [4] and severe in nature. Pain in soft tissue along the site of injection is usually mild in nature and of little troublesome.

The chance of infection in caudal anesthesia is potentially dangerous as site of needle insertion is very closed to perineum. However, it is exceedingly rare, most probably, bacteriostatic or bacteriocidal action of local anesthetic plays an important role to contribute such low incidence of infection. No difference is observed in bacteriological comparison of skin culture or catheter culture in caudal or epidural anesthesia.[14]

Like lumbar epidural and subarachnoid block caudal anesthesia is inevitably associated with some slight risky neurological complication. One permanent neurological damaged was observed by Dawkins in 23000 cases. Exact details are not available.[11] Whatever was the fact, it is obviously true that the occurrence was very small. Above all, pre-existing neurological deficit may be worsened and blamed as complication of anesthesia.

In comparison with lumbar epidural, caudal epidural possesses some definitive advantages over previous one. Caudal anesthesia is more reliable than lumbar epidural with 100% involvement of L5 and S1 spinal nerve roots. Chances of dural puncture are more common in lumbar epidural than caudal procedure. Simultaneously, caudal anesthesia possesses some disadvantages over lumbar epidural. The caudal anesthesia is technically more difficult procedure than lumbar epidural. Recently, such difficulties are easily overcome with the help of nerve stimulator needle and surgical assisted procedure. But, the need of a large amount of local anesthetic for caudal anesthesia always bears a risk of drug toxicity that is the rare incident in case of lumbar epidural.

The lumbar spinal anesthesia is also advantageous over caudal anesthesia. Quick onset and technical easiness make it superior to caudal anesthesia whereas low incidence of postdural puncture headache and more durable anesthesia by single dose caudal make it superior to single dose spinal anesthesia.

Busoni, one of the fathers of pediatric locoregional anesthesia [15,16] introduced caudal anesthesia in pediatric through transsacral route at the level of S2 and S3 intervertebral space.[17] It was safe and easy as caudal through sacral hiatus with minimal chance of contamination from fecal soiling.[18] The needle was inserted at the angle of 45-60 degrees at the level of S2-S3 intervertebral space. In fact, it was possible due to lack of ossification in pediatric patients, but it is not possible in adult life due to complete ossification.

V. Conclusion

Surgical assisted caudal anesthesia is a good and easily approachable device to overcome the anatomical distortion of the sacral hiatus occurred in aged persons. This surgical aided procedure makes the caudal as predictable, predominant and preferable method of anesthesia for lower limbs' surgeries in aged persons. It is exclusively one of the best techniques of anesthesia for the lower limbs' surgeries with devoid of hemodynamic disturbance. The surgical assisted caudal anesthesia is a stunting, but beneficial approach in the world of practicing anesthesia.

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TABLE NO 1 Showing Demographic Profile, Hemodynamic Profile, And Nerve Block Profile.

DEMOGRAPHIC PROFILE	
Age (years)	77.27±5.49
Height (Cm)	157.83±6.48
Weight (Kg)	58.70±5.95
Sex (M:F)	12:18
HEMODYNAMIC PROFILE.	
Systolic blood pressure (mm Hg)	115.89±7.26
H Heart Rate (beats/min)	81.37±5.68
Oxygen Saturation (%)	98.93±0.9
NERVE BLOCK PROFILE.	
Onset time of sensory block.(min)	19.13±4.32
Onset time of motor block.(min)	25.10±4.35
Duration of sensory block. (min)	205.73±12.41
Duration of motor block.(min)	172.20±11.42
Cephalad extension (vertebra)	T12