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Commentary

Comparative Analysis of Caudal *vs* Spinal Anesthesia

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DESCRIPTION

Regional anesthesia techniques play a pivotal role in contemporary surgical practice, offering targeted analgesia, reduced systemic opioid requirements and improved postoperative recovery profiles. Among these techniques, caudal and spinal anesthesia are frequently employed for lower abdominal, pelvic and lower limb surgeries. While both methods aim to achieve effective analgesia and anesthesia, they differ in anatomical approach, onset and duration of action, hemodynamic effects and potential complications. A comparative analysis of caudal versus spinal anesthesia is essential for anesthesiologists seeking to optimize perioperative care based on patient characteristics, surgical requirements and resource availability.

Caudal anesthesia, a subset of epidural block, involves the administration of local anesthetic into the sacral epidural space through the sacral hiatus. It is widely favored in pediatric populations due to its ease of administration and minimal invasiveness. The technique is associated with a favorable safety profile, particularly in children and allows for single-shot administration or continuous infusion *via* a catheter.

However, its major limitation is the variable onset time and sometimes incomplete block, especially in adults, due to the complex anatomy of the sacral epidural space. On the other hand, spinal anesthesia involves the injection of local anesthetic directly into the cerebrospinal fluid within the subarachnoid space, producing rapid, dense sensory and motor blockade. The direct deposition of the anesthetic allows for predictable onset and consistent block height, making it ideal for shorter surgical procedures requiring profound anesthesia.

One of the key differentiating factors between the two techniques is the onset and duration of analgesia. Spinal anesthesia typically produces rapid onset within 3 minutes -10 minutes, achieving complete sensory and motor block suitable for surgical intervention. Caudal anesthesia, in contrast, has a slower onset, particularly in older children and adults, with a more segmental spread that may require higher volumes or additives for adequate surgical anesthesia. The duration of spinal anesthesia depends largely on the type and dose of local anesthetic used; single-shot spinal blocks generally provide reliable anesthesia for90 minutes-150 minutes,whereas caudal blocks may offer extended postoperative analgesia, especially when combined with adjuncts such as opioids, α2-adrenergic agonists, or corticosteroids.

Hemodynamic effects constitute another important distinction. Spinal anesthesia can lead to significant sympathetic blockade, resulting in hypotension and, less commonly, bradycardia. While these effects are generally manageable, they require vigilant monitoring and prompt intervention, especially in elderly or hemodynamically unstable patients. Caudal anesthesia produces comparatively milder sympathetic blockade, making it safer in patients with cardiovascular comorbidities. Moreover, caudal administration preserves motor function to a greater extent, which may facilitate early postoperative mobilization in select patient populations.

Complications associated with each technique must also be considered in comparative decision-making. Spinal anesthesia carries risks of post-dural puncture headache, transient neurological symptoms, and, rarely, spinal hematoma or infection. Caudal anesthesia, although generally safe, can be complicated by inadvertent intravascular injection, dural puncture, or inadequate block requiring supplementation. Pediatric patients tolerate caudal anesthesia particularly well and the technique allows for continuous postoperative analgesia through catheter placement, a significant advantage in managing postoperative pain without systemic opioids.

From a practical standpoint, caudal anesthesia is technically less demanding in children due to the superficial location of the sacral hiatus and the presence of palpable anatomical landmarks. In adults, anatomical variability and higher tissue depth can make caudal access more challenging. Spinal anesthesia, while more technically demanding, provides rapid, predictable anesthesia for surgeries requiring complete motor and sensory blockade and is particularly suitable for cesarean sections, urological procedures and lower limb surgeries. The choice between the two techniques should therefore be guided by

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surgical duration, desired postoperative analgesia, patient age, comorbidities and practitioner expertise.

Both caudal and spinal anesthesia offer distinct advantages and limitations and their selection should be individualized. Spinal anesthesia provides rapid, dense and reliable anesthesia ideal for shorter procedures, while caudal anesthesia excels in providing prolonged postoperative analgesia with minimal hemodynamic compromise, particularly in pediatric and certain adult populations. Understanding these differences allows anesthesiologists to optimize perioperative care, enhance patient comfort and minimize complications. Future research focusing on combination approaches, adjunct use and adjusted dosing regimens may further refine the comparative utility of these regional techniques, enabling clinicians to balance efficacy, safety and patient-centered outcomes.