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Review Article

Vertebral body changes that make spinal anesthesia difficult in geriatric patients

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ABSTRACT

Spinal anaesthesia techniques are important, because age-related structural and degenerative alterations to the spine sometimes make it difficult to deliver spinal anaesthesia to the elderly population. The current understanding of age-related changes in the vertebral column that affect successful administration of spinal anaesthesia is thoroughly examined in this review. Our review focuses on the adverse effects of osteoporotic degenerative changes in older individuals, including reduced disc height, calcified ligaments, osteophyte formation, and narrowed interspinous spaces. These changes collectively complicate landmark identification and needle insertion and increase the risk of traumatic or failed spinal anaesthesia. Even though spinal anaesthesia is frequently a better option for older patients than general anaesthesia, age-related anatomical changes in the vertebral column present serious technical difficulties that can result in block failure and potentially requiring alternative or adapted approaches. The effectiveness of a number of adaptive techniques, including paramedian approaches, ultrasound-guided neuraxial blocks, and the use of alternate access sites in the sacral or lower lumbar spine, is analyzed further in this review. This review article additionally examines the challenges of delivering spinal anaesthesia to geriatric patients with altered spine structure, and investigates future directions in this field and notes a few limitations.

Keywords: Spinal anaesthesia, Geriatric patients, Degenerative changes, Landmark identification, Failed block, Paramedian approach, Ultrasound-guided neuraxial blocks

INTRODUCTION

Spinal anesthesia is most widely used technique for abdominal and lower limb surgeries, especially in elderly patients. Safe spinal anesthesia needs normal spine alignment and clear landmarks for needle entry into the subarachnoid space. This is particularly important in the elderly, as the positions for performing spinal anesthesia in the elderly can be difficult due to various anatomical and physiological changes with increasing age, pathological conditions and polypharmacy.[1]

The structural changes in the vertebral column include osteoporosis. These also include degenerative changes in the intervertebral disc, osteophyte formation, ligament calcification and spinal stenosis. Moreover, these changes can make the landmark identification and needle placement difficult by the anaesthetist.[2]

In geriatric patients, the anatomical barriers to successful spinal anaesthesia due to age are described. Additional techniques, namely ultrasound guidance, paramedian approaches, or different access sites are also explained.

So, understanding both normal and abnormal spine anatomy is important for safe, successful neuraxial blocks.

Anatomy

The spine's anatomy includes the vertebral column and the structures in the vertebral canal.[3]

Vertebral column

Central axis of the human body is formed by the vertebral column, which runs along the midline from the base of the skull to pelvis.[4] It has 33 vertebrae which involves 7 cervical, 12 thoracic, 5 lumbar, 5 sacral and 4 fused coccygeal vertebrae in the early developmental stage.

In the anteroposterior plane, the vertebral column shows four normal curves which are cervical lordosis, thoracic kyphosis, lumbar lordosis, and sacral kyphosis, appears as S-shape in lateral view.[5]

Relevance to spinal anesthesia

Spinal anesthesia, a neuraxial technique in which local anesthetic is directly injected into the subarachnoid space, usually at the L3-L4 or L4-L5 interspaces.[6] These levels are mostly preferred in adults because the spinal cord terminates at conus medullaris around L1, L2.

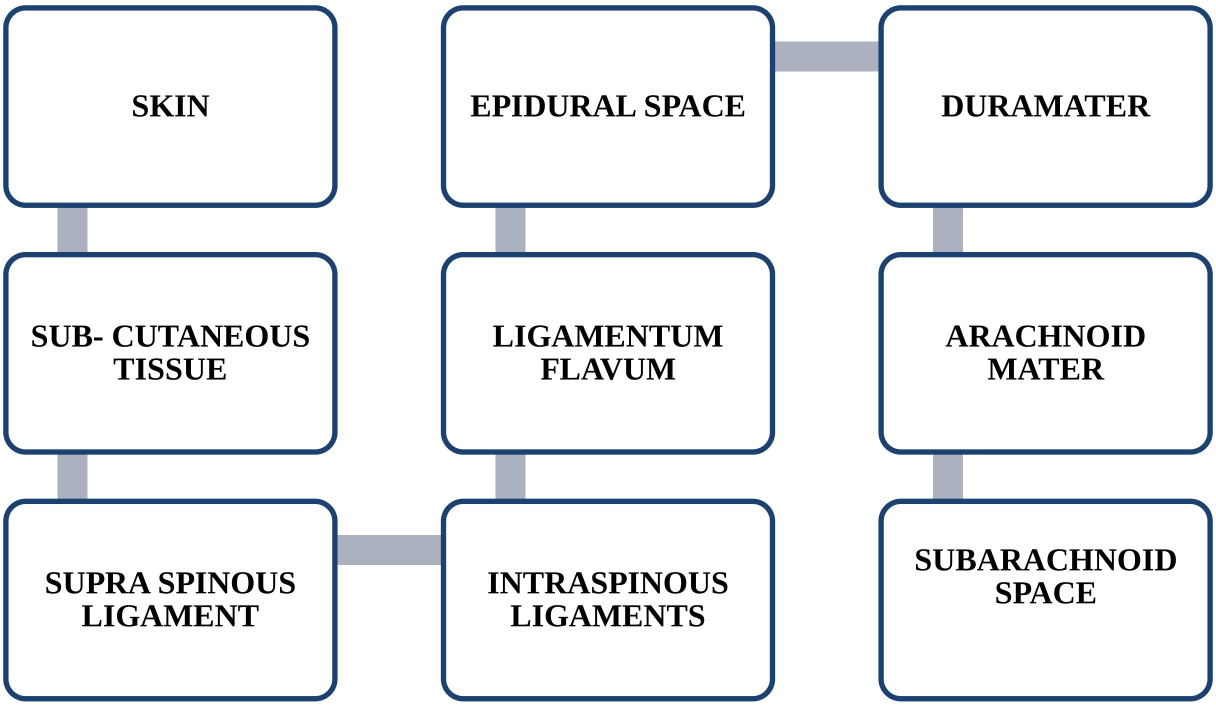

Figure 1: Structures encountered during spinal anesthesia.

Figure 1 shows midline approach for spinal anaesthesia, from superficial to deep: skin, subcutaneous tissue, supraspinous ligament, intraspinous ligaments, ligamentum flavum, epidural space, duramater, arachnoid mater, subarachnoid space.

While performing the technique through midline approach, the needle enters the structures shown in Figure 1.[7]

Osteoporosis

Osteoporosis is a medical condition which weakens and deteriorates the vertebral column. This makes the bones more delicate and prone to vertebral compression fractures that lead to back pain.[8] Osteoporosis occurs when bones lose density and strength over time, making it porous and brittle like a honeycomb structure seen under a microscope. In growing elderly population bone mass decreases, which increases the risk of fractures. Density (how compact the bone is) and quality (bone framework) determines the bone strength.[8,9]

RISK FACTORS LEADING TO OSTEOPOROSIS DEVELOPMENT

Sex

Women are more prone to osteoporosis compared to men because of decreased bone mass and smaller bones. It is still possible for men to develop osteoporosis, after the age of 70.

Age

In osteoporosis, aging slows bone growth and increases bone loss.

Body size

Thin boned women and men are at a higher risk of developing osteoporosis compared to large boned women and men because they have less bone to lose.

Race

African American and Mexican American men are at lower risk of osteoporosis than white men. African American and Mexican American women are at a lower risk than white and Asian women.

Family history

Family history of osteoporosis or hip fracture has a higher chance of getting it too.

Changes to hormones

Low hormone levels can increase the chances of getting the osteoporosis.[9,10]

Symptoms of osteoporosis

Osteoporosis is a "silent disease" with no signs until the bone breaks. Spine fracture symptoms include sharp back pain, height loss, and spine curves like hunchback (kyphosis). Bones get so weak that they snap from small falls, bumps, bending, lifting, or even coughing.[10]

PATHOGENESIS OF OSTEOPOROSIS

A balance between the processes of bone resorption and healthy bone formation is maintained in a healthy bone. Healthy bones continuously build the new bones and break old bone (resorption). Osteoclasts dissolve old bone with acid and enzymes; osteoblasts fill the gap with new bone material. In osteoporosis this balance shifts, with old bone being removed faster than new bone is formed. This is because of prolonged lifespan of osteoclasts and shortened lifespan of osteoblasts.[10]

DEGENERATIVE DISC DISEASE

In routine imaging of the spine, degenerative disc disease is a common finding which may be either due to physiological aging or pathological condition.

Degeneration is commonly caused by any event that has happened to the two functional units which are the adjacent vertebrae and the intervertebral disc. Mechanical overloading, genetic predisposition and smoking are the high-risk factors of the early disc pathology.[11,14] This is important in anatomy and pathophysiology of the intervertebral segment, as lack of nutrients and number of living cells in the disc causes degeneration.[11]

Pathophysiology of degenerative disc disease

Structural changes like reduced disc height, increased stress on facet joint and vertebral body, osteophyte formation calcification of ligaments, facet joint degeneration, and finally spinal stenosis are the characteristic features of degenerated intervertebral disc.[12,14] Low permeability and decreased blood supply to cartilage end plates causes hypoxia, drop in nutrient supply and lower PH.[11,14] This breaks down tissue and kills disc cells via apoptosis.[12] Inflammation develops when there are increased cell apoptosis and debris of the dead cells is not cleared well.[13] This leads to shorter discs, fissure formation with an increased risk of facet joint hypertrophy.[11,12] Bone spurs (osteophytes) are formed when the body tries to stabilize the spine by growing extra bone at vertebral edges, especially front and sides. Increased stress on facet joints leads to calcification of ligaments like the supraspinous, interspinous, and ligamentum flavum.[12] Narrowing of the spinal canal is due to facet joint swelling, looseness, ligamentum flavum enlargement and also in conditions like spondylolisthesis and scoliosis.[12,14]

METHODS

This narrative review is on anatomical challenges and adaptive strategies for spinal anesthesia in geriatric patients with degenerative or altered vertebral morphology.

Search strategy

A literature search was conducted using PubMed, Google Scholar, Science direct and Web of sciences. In addition to database searches, standard anaesthesia textbooks and relevant review articles were taken to provide background information on spinal anatomy, pathophysiology, procedural techniques and adaptive strategies. The search was limited to English-language articles published between 2007 and 2025. The following key words and combinations were used: “Spinal anaesthesia”, “geriatric patients”, “degenerative changes”, “landmark identification”, “failed block”, “paramedian approach”, “ultrasound-guided neuraxial blocks”.

Study selection

We included randomized controlled trials, prospective and retrospective cohort studies, case reports, and systematic reviews that addressed anatomical barriers to spinal anesthesia in older adults.

We excluded non-peer reviewed publications, case series, pediatric studies and articles not available in English.

Data extraction and synthesis

As it is narrative review, we did not conduct a meta-analysis. Instead, we have taken related data on patient age, spinal pathology, techniques used, success rates, complications, adaptive strategies and study conclusions. And we have organized our data thematically under the headings of "anatomical challenges to needle placement", "effect on block characteristics", "trauma-related problems and procedural complications", "adaptive strategies" and "future directions".

Table 1: Impact of spinal abnormalities on structural changes, challenges and preferred approach in geriatric patients.

Spinal abnormality	Structural change/cause	Impact on spinal anesthesia	Choice of approach
Vertebral compression fractures	Reduced vertebral height, wedge deformity	Deformed surface landmarks; difficult midline identification; unpredictable needle trajectory	Taylor's approach Caudal approach
Kyphosis (altered spinal curvature)	Thoracolumbar curvature due to multiple fractures	Difficult patient positioning, inability to achieve flexion, abnormal needle insertion angle, reduced success with midline approach	Paramedian approach Sitting position with flexion
Narrowed interspinous spaces	Vertebral collapse and degeneration	Reduced space for needle entry, increased number of attempts, higher risk of traumatic/bloody tap	Ultrasound guided midline approach Paramedian approach
Narrowed interlaminar spaces	Facet joint hypertrophy and degenerative changes	Difficulty reaching subarachnoid space, increased technical difficulty	Paramedian approach Taylor's approach (L5-S1)
Ligament calcification/ ossification	Interspinous ligament and ligamentum flavum calcification	Loss of resistance during insertion of needle, difficulty identifying ligamentum flavum, increased false loss of resistance	Ultrasound guided approach Paramedian approach
Osteophyte formation (spondylosis)	Bony overgrowth and facet hypertrophy	Blockage of needle path, shift from midline, higher risk of failed block	Taylor's approach Paramedian approach
Spinal canal narrowing	Reduced spinal canal surface and CSF space	Unpredictable spread of local anesthetic, increased risk of patchy block	Paramedian approach Taylor's approach

REVIEW

This section tells, how technical performance of spinal anesthesia is affected by age, it's related complications and the adaptive strategies to be incorporated.

Anatomical challenges to needle placement

In the traditional technique, anatomical landmark palpation plays a major role in the successful spinal anaesthesia administration. Midline, paramedian and lumbosacral approaches can be used.

Landmark disruption and positioning challenges

Ossification of interspinous ligaments causes narrowed interspinous spaces majorly in elderly patients with degenerative spinal disease. Enlarged facet joints causes narrowing of interlaminar spaces leading to difficulty in needle insertion.[15]

Spinal compression fractures results in kyphosis and height loss, making the landmark identification difficult by altering the surface anatomy. Positioning these patients can be painful and challenging. Post dural puncture headache, bloody tap, epidural hematoma, paresthesia and neurological injuries are major complications seen with multiple needle attempts and redirections.[16]

Fracture risk during positioning in kyphosis

Specialized difficulties are faced by patients with thoracolumbar and kyphoscoliosis. Even little stress during sitting or lateral positioning leads to further collapse of the delicate vertebral bodies resulting in limited lumbar flexion, interspinous space narrowing and discomfort to the patient. Aggressive positioning may lead to new fractures or worsen persisting defects making the procedure more complex. Anesthesiologists should adapt to smooth handling techniques to increase the success rate.[17,18]

Effect on block characteristics

Increased risk of failed spinal anaesthesia

When interspinous ligaments and ligamentum flavum get calcified, they loss tissue stretchiness, which makes to spot the ligamentum flavum and raising the chance of getting a false pop signal during the procedure. These changes can block the needle pathway, shifting it from midline and raising the risk of multiple tries, failed blocks and uneven spread of anesthesia.[19,20]

Higher risk of high or patchy block

Spinal stenosis majorly changes cerebrospinal fluid (CSF) flow and nerve root surroundings, directly affecting spinal block success. Degenerative changes or Ossification of posterior longitudinal ligament (OPLL) causes obstruction within the subarachnoid space by narrowing the spinal canal. This results in high or incomplete block based on severity of the stenosis.[21]

Table 1 outlines common osteoporotic vertebral abnormalities, their structural changes, and their specific impacts on procedural success, safety, and efficacy of spinal anesthesia in elderly patients. These changes as a whole contribute to higher failure rates, procedural complications, and the need for alternative techniques such as paramedian approaches, sacral approach or ultrasound guidance.

TRAUMA-RELATED PROBLEMS AND PROCEDURAL COMPLICATIONS

Due to altered pathology of spine, there will be an increased risk of trauma and procedure related complications which are listed below:

Spinal hematoma

Geriatric patients with bleeding disorders are at an increased risk of developing spinal hematoma. It is rare, but when it happens, it is serious.

A large epidemiological study analyzed over 2.7 million neuraxial anesthesia cases across multiple hospitals (Shu et al., 2025). Neurological problems were infrequent but clinically significant, with spinal hematomas happening in a tiny fraction of cases. This confirms neuraxial anesthesia's safety for normal usage while focusing on careful patient selection and monitoring, particularly in high-risk circumstances such as anticoagulation or restricted airways-essential for geriatric and simulation-based training contexts.[22]

Occurrence of spinal and epidural hematoma during neuraxial blockade is correlated with the use of anticoagulants, increased vessel weakness and multiple tries. These aspects raise the risk vessel injury and formation of hematoma.

Vascular injury (bloody tap)

Due to weak epidural veins and venous plexus congestion, especially in situations like spinal stenosis, bloody tap is a common complication during spinal anesthesia in elderly individuals. A vascular puncture is more likely to occur when a needle is difficult to pass through, which raises the chance of an unsuccessful or patchy block and blood in the CSF. Long procedure durations and many needle passes indicate the highest level of technical difficulty, which also raises the risk of problems such post-dural puncture headache, bloody tap, and neurological harm.[23]

Anatomical landmark-based and pre-procedure ultrasound-aided spinal anesthesia techniques were compared in a cohort study by Narkhede et al in elderly patients who underwent orthopedic surgery. The results showed that guidance by ultrasound greatly enhanced first-attempt success rates (90% vs. 50%), decreased the number of needle passes, and shortened procedure time. Furthermore, the ultrasound-guided group had a decreased incidence of vascular damage, including bloody tap, highlighting the importance of imaging in reducing problems related to repeated interventions in elderly patients.[23]

Dural puncture

One common consequence of CSF fluid leakage after dural puncture is post-dural puncture headache (PDPH). This is the most frequent side effect of spinal anesthesia. Age-related degenerative spinal alterations enhance technical challenges during neuraxial techniques, frequently requiring numerous needle attempts, even though the baseline incidence is lower in older patients. The likelihood of an unintentional dural puncture and subsequent PDPH is indirectly increased by this procedural challenge.[24] Its prevalence is also influenced by characteristics relating to the patient, the type of neuraxial anesthesia, and needle-related conditions. Age, patient constitution, and the type of neuraxial anesthesia were found to be important risk variables impacting the occurrence of PDPH in a study by Weinrich et al.[25]

Neural injury

Age-related degenerative spinal changes increase the risk of neural injury during spinal anesthesia, which is a rare but serious complication that is more common in elderly patients. Spinal stenosis decreases the cerebrospinal fluid space, pushing neural tissues closer to the progressing needle. This elevates the risk of direct nerve trauma, which may appear as paresthesia during needle placement or, in extreme cases, permanent neurological problems.[26] A systematic analysis also found that direct needle trauma is a major source of spinal cord injury, with outcomes varying from short-term paresthesia to severe motor dysfunction.[27]

Because of these difficulties and spinal anomalies, using the conventional method to give spinal anesthetic may be challenging or impossible. Few adaptive solutions or alternative procedures that can be utilized interchangeably to improve patient outcomes are available to address such barriers.

ADAPTIVE/ALTERNATIVE STRATEGIES

A systematic approach to adaptation techniques may enhance the results in order to overcome the technical difficulties that arise from the age-related changes to the vertebral column. The evidence supporting these methods is examined in this part, starting with simple changes like different needle procedures and moving on to more advanced approaches like ultrasound guiding and newly developed visualization technologies.

Paramedian approach

The paramedian, commonly referred to as the paraspinous approach, is a lumbar puncture, epidural, or spinal method that starts the needle insertion point almost adjacent to the midline. It goes through the ligamentum flavum and enters the dura while bypassing the supraspinous and interspinous ligaments. The technique avoids narrow or calcified interspinous gaps, especially in older or challenging people. In elderly vulnerable patients with vertebral deformity who have been labelled vulnerable for general anesthesia and whose lumbar puncture by the midline method fails because of the spinal abnormalities, the paramedian route is a safe alternative with a 100% success rate.[28] A new meta-analysis suggests that this method minimizes the incidence of PDPH (post-dural puncture headache) and LBP (lower back pain).[29]

In terms of procedural results, research shows that the paramedian method has a higher first-attempt success rate (85%) than the midline route (45%), with all catheters inserted properly and no patient needing to be converted to general anesthetic.[30] Targeting the lowest possible interspace is an acceptable alternative when paramedian attempts fail or when degenerative alterations are most severe at normal lumbar levels.

Taylor's approach

Lumbosacral spinal anesthesia, or Taylor's method, is a paramedian treatment that targets the L5-S1 interspace.[31] Even after midline and paramedian techniques at upper lumbar levels have failed, the L5-S1 interspace, the biggest intervertebral region in the spine, is still reachable.[31] To access the subarachnoid area, the needle is extended at a 45-55° cephalad notch and medial angle after being placed 1 cm medially and inferiorly to the posterior superior iliac spine.[31] It has been demonstrated that Taylor's method is a useful substitute in difficult spinal anesthetic situations. After several unsuccessful attempts at traditional lumbar levels using both midline and paramedian techniques, a case dealing with a 92-year-old patient with a trochanteric fracture showed that effective subarachnoid block could be obtained via the L5-S1 interspace, enabling simple surgery.[32] Similar to this, when ultrasound is not available, a modified Taylor's method determined by preoperative lumbar radiographic measurements may help patients with severe scoliosis and place needles accurately. This was demonstrated in a 90-year-old patient undergoing femur fracture fixation.[33]

The sacral route can be used to give anesthesia if the lumbar methods (midline, paramedian, and Taylor) are similarly unsuccessful.

Sacral approach

Using anatomical landmarks, the sacral foramina are identified in the sacral approach to subarachnoid block. The third sacral foramen is usually located 2–3 cm lateral and 9-11 cm cephalad to the coccygeal tip, while the second sacral foramen is located roughly 2 cm superior to it.[34] Due to the longer onset of sympathetic blocking, sacral spinal anesthesia typically results in modest hemodynamic alterations, which can be advantageous in high-risk and elderly patients.[34]

Caudal anaesthesia

Caudal anesthesia is another sacral route that is administered via sacral hiatus to reach the caudal epidural region. Children are most frequently treated with caudal anesthesia, a localized anesthetic method, for perioperative care and postoperative analgesia.[35] Despite anatomical difficulties, caudal anesthesia has received increased attention in adult perioperative care, especially in certain conditions, even though it is most frequently used in children.[36] While sacral area is typically less impacted because it is not subjected to similar mechanical force, the lumbar spine frequently has severe degenerative changes in elderly people.[37] Therefore, when lumbar access is difficult, caudal anesthesia-which is given across the sacral hiatus to reach the epidural space-serves as an effective replacement.

Sacral methods and alternate needle procedures can help handle anatomical challenges, but they still rely on accurate landmark identification.

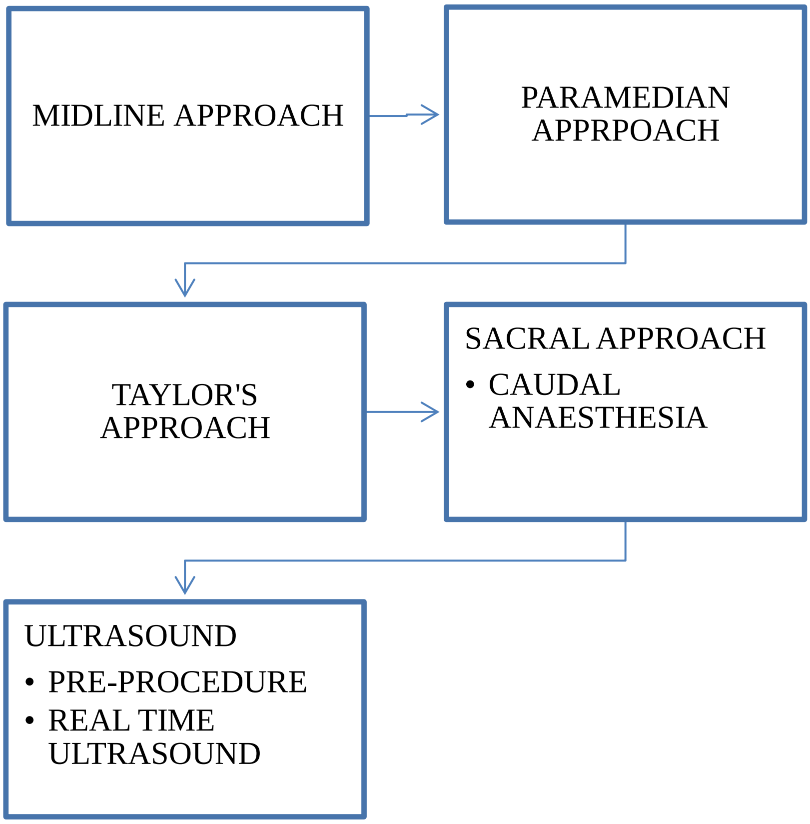

Figure 2: Sequential approach to difficult spinal anaesthesia.

Sequential algorithm for managing difficult spinal anesthesia (Figure 2). Initial approaches include midline, paramedian, Taylor's, and sacral techniques. If these are unsuccessful or anatomy is challenging, alternative options like caudal anesthesia. Ultrasound guidance may be employed either as a pre-procedural mapping tool or in real time. The final step advises investigating accessibility when standard approaches fail.

Ultrasound

Ultrasound has emerged as a crucial tool for increasing success rates, particularly in older patients whose degenerative changes frequently make it difficult to identify landmarks. With its application targeted to each patient's needs, preprocedural ultrasonography improves clinical evaluation by providing real-time information that aids in identifying vulnerable patients and assists anesthetic preparation, especially in complex scenarios.[38]

By enabling physicians to see the target structures directly, watch the needle real time, and verify that the local anesthetic drug has spread properly, ultrasound guidance increases the precision and efficacy of regional anesthesia.[39]

Patil et al observed that the utilization of preprocedural ultrasound for a paramedian spinal anesthesia substantially lowered the frequency of needle insertions, improved initial-pass success rates, and avoided minor complications like radicular discomfort and bloody tap in a potential randomized trial of 70 older individuals undergoing infraumbilical surgery. These findings demonstrated the technique's superiority over the traditional landmark-based approach in patients with challenging spinal anatomy.[40] Similar to this, 72 patients were randomly assigned to two equal groups in a study by Elfattah et al. Group C received spinal anaesthesia using the paramedian anatomical landmark guided technique, while group S received spinal anesthesia using the pre-procedure paramedian ultrasound-guided technique. In comparison to group C, group S had a greater probability of dural puncture success on the initial needle insertion trail. In this study, group S had significantly less needle insertion attempts, passes and redirections than group C. additionally, group C had deeper needle insertions than group S. When compared to anatomical landmark based spinal anesthesia, the ultrasound-guided method demonstrated a much lower number of needle insertions. Elderly patients showed major improvements in pain relief and patient satisfaction. That is why this investigation suggested that spinal anaesthesia could potentially be guided by the use of ultrasonography.[15]

All of these results suggest the use of ultrasound guidance, either before to or during the procedure, as an effective method for treating the age-related spine abnormalities that often make standard landmark procedures more difficult in older patients.

DISCUSSION

Geriatric patients often defined as individuals aged 65 years and above. With the increased trend in geriatric population, the demand for surgical procedures has also increased.[1] Spinal anesthesia is often preferred technique over general anesthesia in elderly population. Supporting this observation, Cao et al conducted a systematic review and meta-analysis of 10 randomized clinical trials involving 3,594 elderly patients undergoing hip fracture surgery and found that regional anesthesia was associated with shorter duration of surgery, reduced intraoperative blood loss, and shorter hospital stay compared with general anesthesia.[41] But spinal anesthesia can sometimes be difficult to perform in elderly population due to age related anatomical and degenerative changes of the spine.[2]

Spinal abnormalities such as osteoporosis, degenerative disc disease and kyphosis cause vertebral body fractures, narrowed interspinous and interlaminar spaces, osteophyte formation and finally spinal stenosis. These abnormalities lead to difficulty in patient positioning, landmark identification, needle insertion, and unpredictable spread of local anaesthesia.[15,16,19,20]

Osteoporotic kyphosis causes risk of fracture during positioning in elderly patients, even with minimal stressing.[16,17] A case report by Otsuki et al described an 87-year-old woman with severe kyphosis who developed a new lumbar vertebral fracture following intraoperative positioning for hip fracture surgery, highlighting the risk of fracture in elderly patients with fragile osteoporotic spines.[42] Degenerative changes like ligament calcification, osteophyte formation and facet joint hypertrophy narrows all the entry points and loss of normal sensation during needle advancement. This further increases the chances of failed block.[19]

Changes in spine anatomy also affect the distribution of local anesthesia. Spinal stenosis decreases cerebrospinal fluid volume and causes an uneven distribution in the subarachnoid space, resulting in unknown consequences. Yoo et al demonstrated that reduced lumbosacral cerebrospinal fluid volume influences the spread of spinal anesthesia, which may explain the unpredictable block characteristics observed in patients with spinal stenosis and degenerative spinal changes.[43] As a result, elderly individuals are more likely to experience high spinal or patchy block. so, understanding abnormal anatomical changes is very important to enhance the success rate.[21,43]

Apart from procedural complication, these anatomical and technical difficulties strongly exacerbate the risk of trauma and adverse outcomes. Vascular damage, defined as a bloody tap, is more common as a result of weak epidural veins and venous plexus congestion. Narkhede et al reported that ultrasound guidance reduced bloody taps and vascular injury by decreasing multiple needle attempts.[23]

Multiple needle attempts increase the possibility of a vascular puncture, which may lead to blood contamination of the cerebrospinal fluid and block failure. Spinal and epidural hematoma, however rare, are serious conditions with possibly life-threatening neurological effects. The risk is especially high in elderly people due to anticoagulant usage, vascular fragility, and frequent needle insertions.[22] A case report by Hajmurad et al described an 80-year-old woman who developed a spinal epidural hematoma (SEH) with neurological deficits after a spinal cord stimulator (SCS) trial.[44]

While the post-dural puncture headache is less common in the elderly, it is however clinically important, particularly in cases of difficult spinal framework and many needle attempts.[24] Finger et al identified multiple puncture attempts as a risk factor for PDPH, and case reports have documented PDPH with subdural hematoma following spinal anesthesia in elderly patients.[45]

Neural damage, although uncommon, is another major concern. Altered vertebral structure and limited cerebrospinal fluid space increase the possibility of direct needle trauma to neural regions, which can result in paralysis, or, in severe cases, lifelong neurological complications.[26,27] A systematic review by Pozza et al. identified needle-related trauma as an important cause of neuraxial spinal cord injury, with motor deficits, sensory loss, and even paraplegia reported in some cases, particularly in elderly patients and those with pre-existing spinal pathology.[46]

In order to overcome these problems, several adaptive techniques have been developed to increase the success of spinal anesthesia in elderly people. The paramedian and Taylor methods offer alternatives that avoid calcified ligaments and restricted midline gaps, resulting in greater success rates in patients with complex anatomy. A case report by Gonçalves et al demonstrated that Taylor's approach enabled successful spinal anesthesia in a 92-year-old patient after failure of the conventional midline approach, highlighting its value in elderly patients with difficult spinal anatomy.[31,32]

Furthermore, pre-procedural ultrasound has emerged as a highly successful method for identifying anatomical landmarks, monitoring needle depth, and guiding needle insertion. Patil et al reported that preprocedural ultrasound-guided paramedian spinal anesthesia improved first-pass success and reduced needle passes, bloody tap, and radicular pain in elderly patients.[40] According to studies, ultrasound guidance reduces the number of attempts, improves first-pass success rates, and lowers the risk of complications like bloody tap.

Research gap

Apart from known anatomical difficulties, there is a gap of combined research on how age-related vertebral changes translate into clinical failure rates, and which specific technical adaptations most reliably improve success in this vulnerable population.

Limitations

Firstly, this is not a systematic review and we did not follow any PRISMA protocols. Our review included only English language articles and did not include information available from other languages. We have mentioned about the complications faced but did not mention the management of the complications. Severely affected or frail patients are not included in the study, showing less generalizability. And I did not include any unpublished data, conference abstracts, letters.

CONCLUSION

Administering spinal anaesthesia to elderly patients involves a complete understanding of age-related spinal alterations, careful technique selection, and the use of advanced imaging technologies like ultrasound guidance improve the success rate by enhancing anatomical visualization. USG guided regional anaesthesia is an evolving and exciting field, providing further improvement in the point of care ultrasonography (POCUS) anywhere and anytime. Emerging technologies and geriatric focused research are expected to further optimize the outcomes. A specialized, patient-specific approach is required to reduce complications and improve procedural success in this high-risk population.

Recommendations

Future directions should involve incorporating techniques, like three-dimensional anatomical imaging which includes pre-procedural CT, MRI which helps the anesthesiologist in predicting abnormal spinal pathologies. By using predictors like age, BMI, palpated landmarks, prior surgery, presence of kyphosis etc., a validated score can be developed for identifying difficult spinal anesthesia in elderly which is very essential. As we have already discussed the growing elderly population, randomized control trails comparing the different adaptive techniques or strategies are really essential in making the technique successful. And also, AI guidance or support can be taken in identifying the exact landmarks, needle positioning, needle insertion depth by training the model. Anesthesiologists should not look for the first pass success rate but also look for patient centered outcomes such as pain and satisfaction level, recovery time, any further complications such as post dural puncture headache (PDPH), lower back pain (LBP).

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REFERENCES

1. Silverstein JH, Rooke GA, Reves JG, McLeskey CH, editors. Geriatric anesthesiology. 2nd ed. Philadelphia: Elsevier Saunders; 2008: 278.
2. Al Harbi, Mohammed K, Alshaghroud S, Aljahdali MM, Ghorab F, Baba F, et al. Regional anesthesia for geriatric population. Saudi J Anesth. 2023;17(4):523-32.
3. Butterworth JF, Mackey DC, Wasnick JD. Spinal, epidural, and caudal blocks. In: Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Cohen NH, Leslie K, eds. Miller’s Anesthesia. 9th ed. Philadelphia: Elsevier; 2019: 1697-738.
4. Orebaugh SL, Eng HC. Neuraxial anatomy (anatomy relevant to neuraxial anesthesia). In: Hadzic A, ed. Hadzic’s Textbook of Regional Anesthesia and Acute Pain Management. 2nd ed. New York: McGraw-Hill Education; 2017: 157-75.
5. Stier GR, Asgarzadie F, Cole DJ. Neurosurgical diseases and trauma of the spine and spinal cord: anesthetic considerations. In: Hagberg CA, Benumof JL, eds. Benumof and Hagberg’s Anesthesia. Philadelphia: Elsevier; 2021.
6. Karunarathna I, Godage S, Rodrigo PN, Jayawardana A, Vidanagama U, Fernando C, et al. Comprehensive review of spinal anaesthesia techniques. Uva Clin Anaesth Intensive Care. 2024.
7. University of Toronto. AnesthesiologyQR: regional anatomy. Toronto: University of Toronto. Available at: https://pie.med.utoronto.ca/anesthesiaqr/AnesthesiaQR_content/AnesthesiaQR_Regional_Anatomy.html. Accessed on 15 April 2026.
8. Spine-health. Osteoporosis. Available at: https://www.spine-health.com/conditions/osteoporosis. Accessed 31 March 2026. Accessed on 15 April 2026.
9. Lane NE. Epidemiology, etiology, and diagnosis of osteoporosis. Am J Obstet Gynecol. 2006;194(2): 3-11.
10. National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS). Osteoporosis. Bethesda (MD): NIAMS. Available at: https://www.niams.nih.gov/health-topics/osteoporosis. Accessed on 15 April 2026.
11. Scarcia L, Pileggi M, Camilli A, Romi A, Bartolo A, Giubbolini F, et al. Degenerative Disc Disease of the Spine: From Anatomy to Pathophysiology and Radiological Appearance, with Morphological and Functional Considerations. J Pers Med. 2022;12(11):1810.
12. Benoist M. Natural history of the aging spine. Eur Spine J. 2003;12(2):86-9.
13. Navone SE, Marfia G, Giannoni A, Beretta M, Guarnaccia L, Gualtierotti R, et al. Inflammatory mediators and signalling pathways controlling intervertebral disc degeneration. Histol Histopathol. 2017;32(6):523-42.

14. Teixeira GQ, Yong Z, Goncalves RM, Kuhn A, Riegger J, Brisby H, et al. Terminal complement complex formation is associated with intervertebral disc degeneration. Eur Spine J. 2021;30(1):217-26.
15. Abd Elfattah HM, El-Hossary ZI, Sayouh EF, Farmawy MS. Pre-procedure paramedian ultrasound-guided versus anatomical landmarks spinal anesthesia in elderly patients undergoing lower limb surgery. J Cardiovasc Dis Res. 2021;12(4).
16. Thangavelan M. Spine surgery under loco-regional anaesthesia in lateral decubitus position for an elderly patient-a risk mitigation approach. IMA Journal (Kauvery Hospital). 2024 Dec. Available at: https://www.kauveryhospital.com/ima-journal/ima-journal-december-2024/spine-surgery-under-loco-regional-anaesthesia-in-lateral-decubitus-position-for-an-elderly-patient-a-risk-mitigation-approach/. Accessed on 15 April 2026.
17. Kaur M, Aujla KS, Gosal JS. Anesthetic Challenges in a Patient with Severe Thoracolumbar Kyphoscoliosis. Anesth Essays Res. 2020;14(1):170-2.
18. Rustagi P. Patkar GA, Tendolkar BA. Management of a case of ankylosing spondylitis for percutaneous nephrolithotomy in prone position under combined spinal epidural anesthesia. Medical J D Y Patil Univer. 2016;9(6):765-7.
19. Nishikawa M, Yoshimura M, Naito K, Yamagata T, Goto H, Hara M, et al. The Symptomatic Calcification and Ossification of the Ligamentum Flavum in the Spine: Our Experience and Review of the Literature. J Clin Med. 2023;13(1):105.
20. Shetty N, Rajesh N, Aishwarya. Osteoporotic Compression Fracture with Anterolisthesis in a Geriatric Diabetic Patient: A Conservative Management Approach. Int J Scient Res Publ. 2025;15(12).
21. Chen PW, Chang CC, Tu TH, Wu JC, Huang WC. Acute Paraplegia Following Spinal Anesthesia in a Patient with Unrecognized Thoracic Ossification of the Posterior Longitudinal Ligament and Spinal Stenosis: A Case Report. Cureus. 2024;16(9):e68950.
22. Shu LP, Ji JM, Mao ZX. Epidemiologic investigation on neurological complications following neuraxial anesthesia in 2.7 million cases in Southwest China. Sci Rep. 2025;15:13497.
23. Narkhede HH, Kane D, Parekh V, Hemantkumar I. A cohort study of anatomical landmark-guided midline versus pre-procedure ultrasound-guided midline technique of spinal anesthesia in elderly patients undergoing orthopedic surgery. J Anaesthesiol Clin Pharmacol. 2019;35(4):522-7.
24. McLeod G, McCartney C, Wildsmith T. Principles and practice of regional anaesthesia. Oxford: Oxford University Press; 2012: 266.
25. Weinrich J, von Heymann C, Henkelmann A, Balzer F, Obbarius A, Ritschl PV, et al. Postdural puncture headache after neuraxial anesthesia: incidence and risk factors. Anaesthesist. 2020;69(12):878-85.
26. Sivevski AG, Karadjova D, Ivanov E, Kartalov A. Neuraxial Anesthesia in the Geriatric Patient. Front Med (Lausanne). 2018;5:254.
27. Pozza DH, Tavares I, Cruz CD, Fonseca S. Spinal Cord Injury and Complications Related to Neuraxial Anaesthesia Procedures: A Systematic Review. Int J Mol Sci. 2023;24(5):4665.
28. Ahsan-ul-Haq M, Amin S, Javaid S. Paramedian technique of spinal anesthesia in elderly patients for hip fracture surgery. J Coll Physicians Surg Pak. 2005;15(3):160-1.
29. Kim SY, Na HS, Park JI, Lee KO, Shin HJ. Comparison of the Effect of Landmark-Based Midline and Paramedian Approaches on Spinal Anesthesia-Related Complications in Adult Patients: A Meta-Analysis of Randomized Controlled Trials. Medicina (Kaunas). 2024;60(1):178.
30. Rabinowitz A, Bourdet B, Minville V, Chassery C, Pianezza A, Colombani A, Eychenne B, Samii K, Fourcade O. The paramedian technique: a superior initial approach to continuous spinal anesthesia in the elderly. Anesth Analg. 2007;105(6):1855-7.
31. NYSORA. Spinal anesthesia. 2018. New York School of Regional Anesthesia; Available at: https://www.nysora.com/techniques/spinal-anesthesia-2/. Accessed on 15 April 2026.
32. Gonçalves D, Roriz D, Teixeira F. Taylor´s approach to subarachnoid block in an elderly patient: a solution after failed conventional approach. Reg Anesth Pain Med. 2021;70:36.
33. Using Lumbar X-Ray to Facilitate Modified Taylor's Approach of Spinal Anesthesia in an Elderly Patient With Scoliosis. Cureus. 2021;13(1):e12556.
34. Paria R, Surroy S, Majumder M, Paria B, Paria A, Das G. Sacral spinal anaesthesia. Indian J Anaesth. 2014;58(1):80-2.
35. Dua A, Afzal M. Caudal Anesthesia. Treasure Island (FL): StatPearls Publishing; 2026.
36. Axmann K, Pieran M, Berta E, Gabrhelík T. Caudal block in adult patients and its use in the perioperative period. Anest. intenziv. Med. 2019;30(1):33-8.
37. Papadakis M, Sapkas G, Papadopoulos EC, Katonis P. Pathophysiology and biomechanics of the aging spine. Open Orthop J. 2011;5:335-42.
38. Perlas A, Chaparro LE, Chin KJ. Lumbar neuraxial ultrasound for spinal and epidural anesthesia: a systematic review and meta-analysis. Reg Anesth Pain Med. 2016;41:251-60.
39. NYSORA. Introduction to ultrasound-guided regional anesthesia, 2018. Available at: https://www.nysora.com/topics/equipment/introduction-ultrasound-guided-regional-anesthesia/. Accessed on 15 April 2026.
40. Sahana Patil DSP, Charulatha DC, Vishal Patil DVP. A Prospective Study Comparing Landmark Technique Versus Preprocedure Ultrasound-Guided Paramedian Spinal Anaesthesia in the Elderly. Int J Med Pharmaceut Res. 2025 Jul;6(4):1512-6.
41. Cao MM, Zhang YW, Sheng RW, Gao W, Kang QR, Gao YC, et al. General Anesthesia Versus Regional

Anesthesia in the Elderly Patients Undergoing Hip Fracture Surgeries: A Systematic Review and Meta-Analysis of Randomized Clinical Trials. World J Surg. 2023;47(6):1444-56.
42. Sasagawa T, Murakami H, Maruhashi Y, Segawa T, Yamamoto D, Shimizu S, et al. Iatrogenic Lumbar Vertebral Fracture during Osteosynthesis for a Trochanteric Fracture of the Femur in Diffuse Idiopathic Skeletal Hyperostosis. Asian Spine J. 2015;9(5):803-6.
43. Yoo S, Han Y, Kim Y, Park SK, Lim YJ, Kim JT. Influence of laminectomy on the lumbosacral cerebrospinal fluid volume: A retrospective magnetic resonance imaging study. Anaesth Intensive Care. 2023;51(4):254-9.
44. Hajmurad S, Rifai KJ, Perez AA, Hall A. Epidural Hematoma in an Elderly Patient With Multiple Comorbidities on Aspirin Following Spinal Cord Stimulator Trial: A Case Report. Pain Med Case Rep. 2025;9(3):161-4.
45. Finger A, Rapsas B, Karayi E, Han J, Ramanujam V. Post-dural Puncture Headache Complicated by Subdural Hematoma in an Elderly Patient Following a Pencil-Point Spinal Needle Anesthesia: A Case Report. Cureus. 2026;18(3):105887.
46. Pozza DH, Tavares I, Cruz CD, Fonseca S. Spinal Cord Injury and Complications Related to Neuraxial Anaesthesia Procedures: A Systematic Review. Int. J. Mol. Sci. 2023;24:4665.

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