

REVIEW

Anaesthetic considerations for high-risk patient kyphoplasty

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ABSTRACT

Patients with vertebral compression fractures are often indicated for balloon kyphoplasty. Many of them are elderly with severe comorbidities, which puts them at high risk for general anaesthesia. Surgery under infiltration of local anaesthetic with or without mild sedation is therefore the preferred technique used by many surgeons. However, patients reported moderate-to-severe pain during the procedure. A combination of regional anaesthesia with analgo-sedation offers an interesting alternative to general anaesthesia as well as infiltration administered by the surgeon. In this article we present, apart from general anaesthesia, various regional anaesthetic techniques suitable for high-risk patients, including neuraxial anaesthesia, paravertebral block as well as a novel “erector spinae plane block” at the level of the fractured vertebra. We explore their effectiveness and safety profile, as well as advantage of supplementation of adequate analgo-sedation (Ref. 40). Text in PDF www.elis.sk

KEY WORDS: erector spinae plane block, kyphoplasty, regional anaesthesia, paravertebral block, neuraxial anaesthesia.

Introduction

Percutaneous balloon kyphoplasty is one of the minimally invasive surgical techniques used for the treatment of vertebral fractures. This technique is associated with good fracture stabilization as well as early reduction in postoperative pain. The incidence rates of complications and side effects are low. The most common indication for balloon kyphoplasty is a painful compressive osteoporotic fracture of the vertebral body (1). The actual operation consists of inserting a needle into the body of the vertebra and then of balloon dilatation under direct CT or biplane fluoroscopic guidance. Inflating the balloon partially corrects the shape of the vertebral body to its original height and kyphosis angulation, and creates a cavity. It is then filled with bone cement, stabilizing the vertebral body in this position. The procedure may be performed under local, general or regional anaesthesia, sedation or their combinations, depending on the location and number of vertebrae involved.

Technique overview

The most common anaesthetic techniques used are general anaesthesia and local infiltration anaesthesia, which can be combined with sedation/anoxiolysis and monitored anaesthesia care (2, 3).

General anaesthesia provides the patient with good perioperative comfort and stable hemodynamic parameters compared to local anaesthesia. On the other hand, it increases the incidence of adverse effects such as PONV, sore throat secondary to the tracheal intubation (4), myocardial ischemia and lung infection after the operation (3). In consequence of the required presence of an anaesthesiologist and anaesthetic equipment in the setting of general anaesthesia, its financial costs are higher as compared to that of local infiltration (2, 3). On the other hand, general anaesthesia reduces the discomfort for patients with compressive vertebral fractures during positioning to the prone position as well as perioperatively. The use of general anaesthesia has been described to achieve better outcomes of kyphosis correction as well as recovery of the vertebral body size and configuration as compared to local anaesthesia (5).

Surgeon-administered *local infiltration anaesthesia* is a commonly used technique which is considered clinically effective, safe, and also cost-effective compared to general anaesthesia (2, 3, 6). However, the use of local infiltration anaesthesia may lead to a high incidence of moderate to severe perioperative pain, tachycardia, hypertension and consequently to a reduction in patient compliance during surgery (2). This may limit its use in high-risk patients who may not tolerate such a stress response due to severe cardiac or respiratory limitations. The addition of analgesia with or without sedation/anoxiolysis and monitored anaesthesia care significantly

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lowers the intensity of pain compared to local infiltration anaesthesia alone and reduces the side effects or complications associated with general anaesthesia (2). Benzodiazepines, propofol and opioids are traditionally used for monitored anaesthesia care (7). However, remifentanyl and dexmedetomidine seem to be viable options for minimally invasive corrections of compressive vertebral fractures in the elderly (8). An intraosseous injection of local anaesthetic into the vertebral body combined with infiltration of skin and a separate injection of local anaesthetic to the periosteum have been associated with decreased levels of perioperative and postoperative pain (9). One study highlighted the fact that orally administered sedation combined with local anaesthetic infiltration should only be reserved for low-risk patients in office-based settings (10). A better anaesthetic effect can be achieved by adding an extrapedicular injection of local anaesthetic to the traditional local infiltration administered by the surgeon (11).

Regional anaesthesia techniques

Epidural anaesthesia provides an adequate degree of perioperative anaesthesia at the level of thoracic vertebra but can also adversely affect respiration by the motor block of the intercostal respiratory muscles. The vital capacity and FEV1 (forced expiratory volume) parameters can decrease down to 20–30 % of the basal values (4). The use of epidural anaesthesia makes the fine titration of the anaesthetised area difficult. The puncture of the epidural space, itself near the vertebral fracture, can be tricky, sore or even impossible. Moreover, the patient's positioning for epidural anaesthesia may potentially worsen the degree of the vertebral fracture (2). Nevertheless, segmental epidural anaesthesia for percutaneous kyphoplasty was successfully reported in literature (12). The limitation of this study lies in the inclusion of ASA I–III patients only, whilst majority of the patients undergoing kyphoplasty fall into the high-risk category with multiple co-morbidities, often ASA IV. In the Apan study (12), the majority of his 26 patients presented with vertebral fractures in the lumbar area, where epidural anaesthesia has limited side effects on respiration as compared to the thoracic region. One case report describes the „use of epidural catheter for intermittent titration of epidural analgesia“ in a high-risk patient (13). However, the patient received a 3 + 15-ml bolus, which can correctly be considered a titration for optimal analgesia and avoidance of general anaesthesia and/or moderate-to-deep sedation, but not a titration option to reduce cardiovascular and respiratory adverse effects. A case report by Soulioti (14) describes an epidural catheter inserted under fluoroscopic guidance at the level of L3/4. A high-risk (ASA IV) patient underwent L2 balloon kyphoplasty and percutaneous L1–L3 fusion with no additional analgesia except for i.v. paracetamol. During the three-hour surgery, the patient received three further doses of local anaesthetic via an epidural catheter.

Spinal anaesthesia

Souvatzis (15) described a case series of eleven patients scheduled for lower thoracic or lumbar kyphoplasty (Th11–L4). In one patient, the spinal anaesthesia was unsuccessful for technical reasons and another five patients required additional i.v. opiates for

analgesia. The authors could not determine the adequate level of spinal anaesthesia based on the surgical site but suggested that spinal anaesthesia may be an adequate technique for kyphoplasty. A case report by Hannallah describes a 93-year-old high-risk patient. The interventional radiologist inserted a spinal needle into the subarachnoid space at the L3/L4 interspace under biplane fluoroscopic guidance in a prone position for a multilevel L1 and L2 kyphoplasty. A low dose of bupivacaine with a small dose of fentanyl was injected into the subarachnoid space and rapidly produced satisfactory anaesthesia (16).

Segmental spinal anaesthesia is another theoretical alternative, but there is a lack of robust evidence for it. A review by le Roux et al shows that segmental spinal anaesthesia at the thoracic level is both a feasible and adequate anaesthesia technique in a wide range of patients and various surgical procedures. It is also suitable for high-risk patients (17). A case report by Zundert describes spinal anaesthesia for cholecystectomy in a patient with severe obstructive lung disease. The puncture was performed at the 10th thoracic interspace with a sensory block extending between the third thoracic and second lumbar dermatomes without respiratory distress (18). A case report by Mehta and colleagues described a patient with a dilated cardiomyopathy with an ejection fraction reduced to 20 % and interstitial lung disease. A laparoscopic cholecystectomy was performed with a continuous thoracic spinal anaesthesia as a sole anaesthetic technique (19).

Ultrasound-guided thoracic paravertebral block

Bilateral paravertebral block is a long-used anaesthetic and analgesic technique, effective in various operations with a clear mechanism and site of action, namely it blocks neurological structures (branches of the spinal nerve) contained within the paravertebral space (20). Pneumothorax is a specific complication at the thoracic level, which is a potentially life-threatening condition in a patient with respiratory compromise. Ultrasound-guided technique can reduce this complication below 0.4 % (21). In a retrospective study by Pace et al., six complications including bradycardia with hypotension, vasovagal episode, and possible local anaesthetic toxicity were reported out of over 1,400 paravertebral blocks (22). A study preprint by Tang et al (23) shows that in comparison with local infiltration analgesia, analgesia achieved with the paravertebral block is more effective in reducing intraoperative pain scores and opioid consumption.

Erector spinae plane block (ESP block) was first described in 2016 for the treatment of chronic pain (24). Due to its simplicity, safety, high efficiency and wide range of indications, it has become one of the basic blocks that can be used by almost every anaesthesiologist in their clinical practice (25). ESP block is associated with a low risk of complications. Structures such as main vessels, pleura or spinal cord are far from the needle tip (26). Although we still do not clearly understand the mechanism of its action, the ESP block has been widely used for the treatment of postoperative pain in a variety of operations in thoracic and abdominal surgery, breast surgery, cardiac surgery and spinal surgery in recent years (27). The dorsal part of the spine is innervated by posterior branches of the spinal nerves (28), which are blocked by the effect of a local anaesthetic in ESP block (29). Although the use of ESP block has

been successfully described in vertebroplasty (30), kyphoplasty is a more complex surgery associated with a higher degree of perioperative pain as compared to vertebroplasty (31). Kyphoplasty involves manipulating the surgical instruments inside the fractured vertebra and expanding the body of vertebra with a high-pressure balloon to correct the kyphosis and create a cavity for the bone cement (1). One case report described the use of ESP block in kyphoplasty in combination with propofol sedation (32). Propofol sedation can be replaced by remifentanyl, which allows for fine titration of the desired effect and rapid recovery after ceasing the infusion. Dexmedetomidine is associated with a lower incidence of respiratory depression but with a higher degree of hypotension and bradycardia as compared to remifentanyl. It is also less effective for pain relief as it requires a more frequent supplementation by opioids in the perioperative period (8).

Discussion

Regional anaesthesia offers a viable alternative to general anaesthesia for high-risk patients, especially for frail, elderly patients with multiple comorbidities or patients with impaired pulmonary function. The aim is to avoid intubation with pressure-controlled mechanical lung ventilation and consequential risk of postoperative pulmonary complications. The most common respiratory complications for vulnerable patients are pneumonia and exacerbation of pre-existing lung disease (33), acute lung injury, respiratory failure, atelectasis, pneumothorax and pulmonary embolism. The decrease in lung compliance is further exacerbated by artificial lung ventilation, while ventilator-induced lung injury can further accelerate the fibroproliferative process through tissue distension, atelectasis, and hyperoxia (34). The neuromuscular blockade, used in general anaesthesia, also increases the risk of postoperative pulmonary complications (35). Regional anaesthesia is, in general, a technique preferred over general anaesthesia in patients with interstitial lung disease (34).

In the modern era of perioperative medicine, ultrasound is ubiquitous. Ultrasound allows for reliable real-time needle insertion and observation of local anaesthetic spread. The performance of fascial plane blocks such as ESP block and other novel techniques are therefore relatively easy and safe. These new blocks are commonly used in clinical practice despite the limited high-quality evidence for their effectiveness. There are several case reports, cadaver studies, imaging studies and narrative reviews with unclear conclusions in relation to the mechanism of action. There are two theories. The first lies in the local effect on nociceptors and neurons within the plane itself or within adjacent muscle and tissue compartments. The second is explained by vascular absorption of local anaesthetic and a systemic analgesic effect at distant sites. Direct evidence is presently lacking, while analgesia of ESP block is unpredictable and variable as a result of a myriad of factors at play (36). A meta-analysis of available trials on ESP block effectiveness highlighted the need of a higher quality of evidence (37)

For larger and more demanding spinal operations, the ESP block is successfully used (38, 39) as a part of multimodal anal-

gesia. When compared with local anaesthesia, it shows a significantly higher analgesic potential (40) for selected spinal operations.

Kyphoplasty involves an acute or subacute fracture operation performed in the prone position, while some regional anaesthesia techniques can also be performed in the prone position. It is necessary to choose an adequate analgesia technique and anxiolysis to allow the patient to be transferred to the operating table, then placed in the prone position and properly supported while providing the surgeon with optimal access and eliminating stress and pain for the patient.

Conclusion

The presented review presents a range of anaesthetic management options for high-risk patients, i.e., for the elderly, frail patients, those with significant respiratory compromise or those undergoing surgical fixation of an acute or subacute osteoporotic thoracic fracture. Kyphoplasty as a minimally invasive procedure, together with an appropriately chosen technique of regional anaesthesia, can eliminate the need for general anaesthesia and thus reduce the number of peri- and postoperative complications. A multimodal approach with erector spinae plane block is a new and simple regional anaesthesia technique, which in combination with mild analgo-sedation seems to provide an effective and sufficient alternative for perioperative surgical anaesthesia.

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