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Review

Recent updates on interscalene brachial plexus block for shoulder surgery

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Interscalene brachial plexus block (ISBPB) provides optimal analgesia for shoulder surgery. However, several limitations still exist, including the short duration of analgesia, rebound pain, a high incidence of unilateral diaphragmatic paresis, and potential risk of nerve damage, prompting the search for alternative techniques. Many alternatives to ISBPB have been studied to alleviate these concerns, and clinicians should choose an appropriate option based on the patient's condition. In this mini-review, we aimed to present recent updates on ISBPB while discussing our clinical experiences in shoulder surgery.

Keywords: Brachial plexus; Interscalene brachial plexus block; Peripheral nerve block; Shoulder surgery.

INTRODUCTION

Interscalene brachial plexus block (ISBPB) is the most widely used postoperative analgesic technique for shoulder surgeries [1]. It not only provides excellent postoperative analgesia, but also reduce pain scores and opioid consumption [2]. However, ISBPB has several concerns, including a short duration of analgesia, rebound pain [3], a high incidence of unilateral diaphragmatic paresis [4], and a potential risk of nerve damage by targeting nerve roots in the neck rather than peripheral nerves [5]. Consequently, many researchers have sought to find alternative strategies or refine the existing blocks to reduce the complications of ISBPB. In line with this, the regional anesthesia team at our institution has performed several clinical studies aimed at improving the analgesic effect while decreasing the risk of ISBPB in shoulder surgeries [6-8]. Therefore, in this mini-review, we present recent updates on ISBPB along with discussing our clinical experiences in shoulder surgery. First, we discuss the advantages and disadvantages of several strategies for prolonging analgesic duration in single-shot ISBPB. Second, we discuss strategies to reduce the incidence of hemidiaphragmatic paresis after ISBPB and latest research on the alternatives to ISBPB.

STRATEGIES FOR PROLONGING THE ANALGESIC DURATION OF SINGLE-SHOT ISBPB

The average analgesic duration after single-injection ISBPB with commonly used local anesthetics is 8–12 h, which falls short of providing satisfactory postoperative pain relief on the first night of surgery. Therefore, several approaches including continuous ISBPB with a perineural catheter [9], perineural or intravenous (IV) additives [10], and liposomal bupivacaine [11] have been investigated to increase the analgesic duration after single-shot ISBPB. Here, we discuss the advantages and disadvantages of these strategies.

Continuous ISBPB

A continuous peripheral nerve block is one of the strate-

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gies that can overcome the short duration of single-shot ISBPB by delivering a constant infusion of local anesthetics through a perineural catheter [12]. Clinical studies have demonstrated superior analgesia for up to 48 h after major shoulder surgery without increasing side effects [9]. However, continuous blocks with perineural catheter are labor intensive, may infringe on the surgical field, carry the risk of infection, myotoxicity, and phrenic nerve palsy, and can result in secondary failure related to catheter dislodgement [13]. Taken together, continuous ISBPB may be a useful strategy to prolong the analgesic duration; however, anesthesiologists need to weigh the risks and benefits of continuous ISBPB for shoulder surgery.

Perineural or IV additives (dexamethasone or dexmedetomidine)

The use of perineural or IV additives, such as dexamethasone or dexmedetomidine, is a promising strategy for prolonging the duration of analgesia. However, the safety profiles of off-label perineural injections of most additives have not yet been confirmed; therefore, caution is required [14]. Alternatively, IV administration of several additives, including dexmedetomidine and dexamethasone, can provide prolonged analgesia while avoiding the theoretical risks inherent to perineural injection [7,8,15,16]. In our previous study comparing the effective dose of IV dexmedetomidine to prolong the analgesic duration of ISBPB, we found that IV dexmedetomidine (2.0 μg/kg) significantly increased the time to first pain at the surgical site following ISBPB. However, these extended analgesic effects were not observed at a dose of 0.5 and 1.0 μg/kg [7]. In a subsequent study [8], we demonstrated that IV dexamethasone (0.11 mg/kg) significantly prolonged the time to first rescue analgesic request (1.6-fold compared with the control group) following ropivacaine ISBPB analgesia. Moreover, the co-administration of IV dexamethasone (0.11 mg/kg) and IV dexmedetomidine (1.0 μg/kg) further increased this time (3.8-fold compared with IV dexamethasone alone). This finding is clinically important because 50% of the patients receiving the two drugs did not require rescue analgesics for up to 72 h postoperatively. Taken together, IV administration of dexmedetomidine and dexamethasone may provide prolonged analgesia, but the optimal dose has not yet been determined, and further studies are warranted to clarify this point. While conducting clinical studies using additives in Korea, it should be considered that the use of IV dexamethasone, IV dexmedetomidine, perineural dexamethasone, or perineural dexmedetomidine for the purpose of prolonging the duration of analgesia must be approved by the Korean Food and Drug Administration.

Liposomal bupivacaine

Liposomal bupivacaine was introduced to prolong the duration of single-shot ISBPB and has recently been approved for use in interscalene blocks [11]. Its mechanism of action is due to the structural characteristics of the capsule by multivesicular liposomal lipid bilayers, which leads to a slow release and maintains a constant plasma concentration; thus, prolonging its effects for up to 72 h after a single injection [17-19]. Therefore, it may be a reasonable alternative to other analgesic techniques. However, recent evidence has demonstrated that the addition of liposomal bupivacaine appears to have no extended analgesic and opioid-sparing effects when compared with bupivacaine alone [20] or with adjuvant dexamethasone used in ISBPB [21]. However, drawing a clear conclusion from the current standpoint is complex, and further studies are needed for clarification.

REBOUND PAIN

Patients who receive ISBPB experience excellent pain control while the block is active, but they may experience significantly more pain than those who do not receive ISBPB 24 h after shoulder surgery [2]. This phenomenon is known as rebound pain and is defined as a dramatic increase in pain once the peripheral nerve block dissipates [22]. Recently, addition of perineural dexamethasone to ISBPB using ropivacaine led to a much smoother resolution of ISBPB and reflected in a significantly smaller increase in pain after block resolution and a significantly lower incidence of rebound pain compared with that in the control group (37.1% and 82.9%, $P < 0.001$) [23]. However, the perineural use of dexamethasone is not currently approved in Korea, and there have been no long-term studies on its safety. A recent retrospective study identified IV dexamethasone administration as a potentially modifiable independent risk factor associated with a lower incidence of rebound pain after peripheral nerve block [3]. Further studies using IV dexamethasone are warranted to clarify its effect on rebound pain.

DIAPHRAGM SPARING NERVE BLOCK FOR SHOULDER SURGERY

ISBPB is usually accompanied by hemidiaphragmatic paresis due to an inadvertent phrenic nerve blockade. Hemidiaphragmatic paresis has been reported to occur in up to 100% of the patients receiving ISBPB because the phrenic nerve runs close to the brachial plexus at the C5 and C6 nerve root levels [4,6]. This side effect has little impact on healthy patients, but can be dangerous in patients with preexisting pulmonary complications [24]. This adverse effect has led to an interest in the investigation of potential phrenic nerve-sparing nerve blocks. Here, recent updates regarding the same are discussed.

Extrafascial vs. intrafascial injection for ISBPB

Extrafascial injection for ISBPB (Fig. 1) reduces the incidence of hemidiaphragmatic paresis and affects pulmonary function while providing analgesia similar to a conventional intrafascial injection [25]. Additionally, this may reduce the potential for neurologic injury inherent to ISBPB (see below section “risk of nerve damage”).

Supraclavicular brachial plexus block

The supraclavicular brachial plexus block may be considered an effective and safe alternative to ISBPB for shoulder surgery, especially in patients with preexisting pulmonary impairment [26]. When performing supraclavicular brachial plexus block, we found that the incidence of hemidiaphragmatic paresis was effectively reduced when the local anesthetic was injected primarily in the corner pocket (20 ml) and secondarily inside the neural cluster (5 ml) during the right-sided supraclavicular brachial plexus block [27].

Refining ISBPB: Superior trunk block

Injection around the superior trunk of the brachial plexus is an alternative technique that can reduce the risk of hemidiaphragmatic paresis [6,24,28]. The superior trunk is formed by fusion of the C5 and C6 nerve roots. Therefore, local anesthetic injection around the superior trunk should produce similar analgesia in the shoulder, because the major terminal nerves innervating the shoulder arise distal to the superior trunk (Fig. 2). Moreover, the injection site is farther away from the phrenic nerve, which theoretically reduces the risk of hemidiaphragmatic paresis. Based on this, we performed a non-inferiority clinical trial comparing ISBPB with a superior trunk block, in which the superior trunk block provided postoperative shoulder analgesia equivalent to ISBPB, as demonstrated by similar pain scores, duration of analgesia, and 24 h opioid consumption [6]. Our findings were confirmed by another previous study that prospectively compared ISBPB with superior trunk block [24]. They also observed less frequent hemidiaphragmatic paralysis in the superior trunk block group.

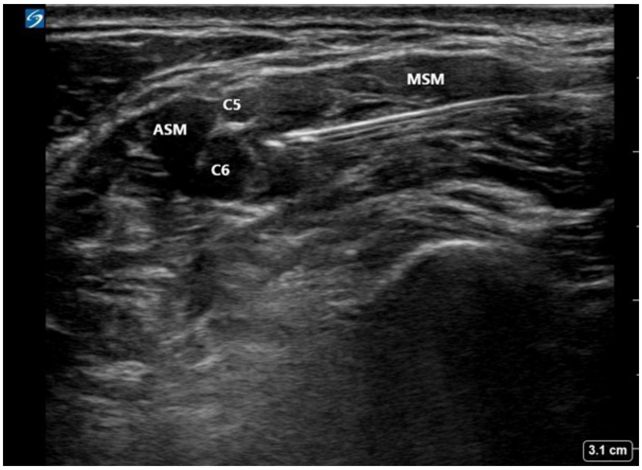

Fig. 1. Ultrasound image after extrafascial interscalene brachial plexus block. ASM: anterior scalene muscle, MSM: middle scalene muscle.

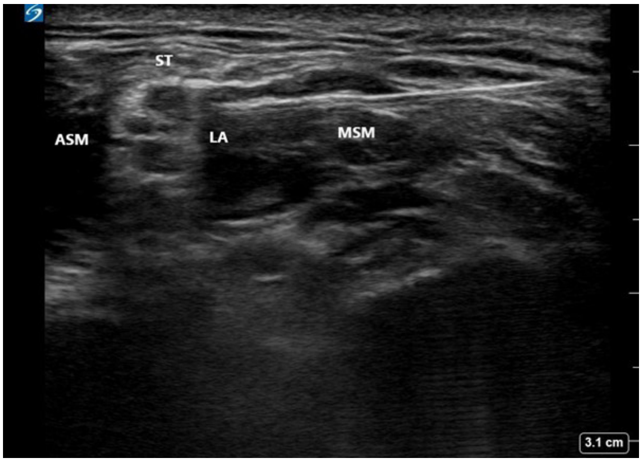

Fig. 2. Ultrasound image after superior trunk block. ASM: anterior scalene muscle, LA: local anesthetics, MSM: middle scalene muscle, ST: superior trunk.

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Alternative shoulder blocks (suprascapular nerve block or axillary nerve block)

Another strategy to reduce the risk of hemidiaphragmatic paresis is to inject local anesthetic at the terminal nerves that innervate the shoulder more distal to the superior trunk [29]. A shoulder block is an alternative approach that blocks the suprascapular and axillary nerves [30]. These two nerves innervate majority of the shoulder with additional minor contributions from the subscapular and lateral pectoral nerves [31]. Theoretically, the shoulder block may spare pulmonary function and diaphragmatic movement. Compared with ISBPB, suprascapular and axillary nerve blocks reduced the incidence of hemidiaphragmatic paresis and pulmonary dysfunction, while providing similar postoperative analgesia [32-35].

OTHER STRATEGIES TO REDUCE THE INCIDENCE OF HEMIDIAPHRAGMATIC PARESIS: LIPOSOMAL BUPIVACAINE

Addition of liposomal bupivacaine is a viable option without refining the ISBPB technique. Adding liposomal bupivacaine to bupivacaine in an ISBPB resulted in statistically significant reductions in diaphragm excursion and pulmonary function tested 24 h after block placement compared with bupivacaine alone. However, this reduction was within the range of normal diaphragmatic function [36].

RISK OF NERVE DAMAGE

Other concerns when conducting ISBPB with a posterior approach include the risk of intraneural injection into the relatively unprotected roots [37,38] and injury to the dorsal scapular nerve or long thoracic nerve (Supplementary Video 1) [39]. There is growing evidence that an intraplexus injection of ISBPB can increase the potential of neurologic injury [40]. The C6 nerve root often shows intra-root splitting in the interscalene groove, which poses a risk of intraneural injection [37,38]. Unfortunately, ultrasound does not entirely protect against intraneural injections [37,38]. In addition, caution is required when advancing the needle because there are risks of encountering the dorsal scapular nerve and the long thoracic nerve crossing the middle scalene muscle [39]. To reduce the risk of nerve damage, we recommend a nerve stimulator during ultrasound-guided ISBPB using the posterior approach.

CONCLUSION

ISBPB provides optimal analgesia for shoulder surgery; however, there are concerns about the associated risks. There are several alternative techniques for ISBPB, and clinicians should select the appropriate option based on the patient's condition.

SUPPLEMENTARY MATERIALS

Supplementary video is available at https://doi.org/10.17085/apm.22254.

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CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article, as no datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTIONS

Conceptualization: RyungA Kang, Justin Sangwook Ko. Methodology: RyungA Kang, Justin Sangwook Ko. Writing - original draft: RyungA Kang, Justin Sangwook Ko. Writing - review & editing: RyungA Kang, Justin Sangwook Ko. Investigation: RyungA Kang, Justin Sangwook Ko. Resources: RyungA Kang, Justin Sangwook Ko. Supervision: RyungA Kang, Justin Sangwook Ko. Validation: RyungA Kang, Justin Sangwook Ko.

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