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A Retrospective Analysis of the Analgesic and Adverse Effects of Interscalene Brachial Plexus Block During Arthroscopic Shoulder Surgery

Artroskopik Omuz Cerrahisi Sırasında İnterskalen Brakiyal Pleksus Bloğunun Analjezik ve Yan Etkilerinin Retrospektif Analizi

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ABSTRACT

Objective: Interscalene block (ISB) has become an accepted and effective technique of anesthetic and perioperative analgesia, in arthroscopic shoulder surgery. We aimed to retrospectively evaluate a series of patients who underwent arthroscopic shoulder surgery under combined ISB and general anesthesia.

Methods: A retrospective chart review was performed consisting 641 patients who had ISB performed between June 2007 – January 2013 for success rates, side effects and complications.

Results: The overall success rate of the blocks was 96.5%, with a mean postoperative analgesia time of 15.5 hours. While no patient suffered permanent nerve injury as a result of ISB, the most common complication noted in this analysis was local anesthetic-related convulsion, which occurred in only one patient.

Conclusion: Interscalene block and general anesthesia combination, which provides high patient satisfaction with low side effects and complication profile, can be recommended for patients undergoing arthroscopic shoulder surgery.

Keywords: Shoulder, arthroscopy, brachial plexus block, general anesthesia

ÖZ

Amaç: İnterskalen blok (İSB), artroskopik omuz cerrahisinde anestezi ve perioperatif analjezi için kabul görmüş ve etkili bir yöntem hâline gelmiştir. Kombine İSB ve genel anestezi altında artroskopik omuz cerrahisi uygulanan bir hasta serisini retrospektif olarak değerlendirmeyi amaçladık.

Yöntem: Başarı oranları, yan etkiler ve komplikasyonlar için Haziran 2007 - Ocak 2013 arasında İSB uygulanan 641 hastayı içeren retrospektif bir dosya incelemesi yapıldı.

Bulgular: Genel başarılı blok oranı %96,5 ve ortalama postoperatif analjezi süresi 15,5 saatti. Hiçbir hastada İSB'ye bağlı kalıcı sinir hasarı görülmezken, karşılaşılan en önemli komplikasyon sadece 1 hastada görülen lokal anestezik ilişkili konvülsiyondu.

Sonuç: Artroskopik omuz cerrahisi uygulanan hastalarda, düşük yan etki ve komplikasyon profili ile yüksek hasta memnuniyeti sağlayan ISB ve genel anestezi kombinasyonu önerilebilir.

Anahtar sözcükler: Omuz, artroskopi, brakial pleksus bloğu, genel anestezi

INTRODUCTION

Interscalene block (ISB) has become an accepted and effective method for anesthesia and perioperative analgesia in proximal upper extremity operations, especially for arthroscopic shoulder surgery (1). The ISB may provide many advantages over general anesthesia (GA) including effective peri-operative analgesia, reduced need for supplemental opioids, which in turn results in diminished postoperative nausea and vomiting, shortened post-anesthesia care unit (PACU) stays, early discharge and increased patient satisfaction (2). Although ISB serves such advantages it can be either applied alone or in combination with GA according to intraoperative patient position related issues (3).

We aimed to retrospectively analyze and determine success and satisfaction rates, duration of analgesia, side effects and complications in patients who underwent arthroscopic shoulder surgery with combined ISB and GA in Gazi University Faculty of Medicine.

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MATERIAL and METHODS

Following ethical committee approval (5.7.2022 and 2022-882), retrospective chart review was performed in patients who had undergone elective arthroscopic shoulder surgery under single shot ISB by Winnie approach combined with GA between June 2007 – January 2013. All the anesthetic records were reviewed for demographic properties, postoperative analgesia times and success and complication rates.

Patients who required supplemental remifentanil infusion in response to the surgical incision intraoperatively were determined as failed ISB. According to the records block-related early side effects and complicatons, such as blood aspiration, hematoma, local anesthetic systemic toxicity (LAST), cardiac events, spinal injections, Horner's Syndrome, hoarseness, dyspnea, respiratory distress and pneumothorax were documented. Block efficacy and postoperative pain were evaluated by Visual Analog Scale (VAS) recordings in the recovery room. Patients with lack of analgesia who needed additional analgesics were accepted as failure of ISB. In the orthopedic ward, the time when the patient asked for an analgesic was recorded from orthopedic ward records and the time from the end of local anesthetic injection to the first analgesic application was accepted as the "analgesia time".

Neurological complications (motor/sensory deficits, paresthesias and dysesthesias) were investigated from the orthopedic ward records in the first 24 hours of the postoperative period until discharge. The long-term neurological deficits were assessed from the surgeons' 15th postoperative day follow-up records.

Statistical Analysis

Data were processed using the SPSS (Statistical Package for Social Sciences; SPSS Inc., Chicago, IL) 16 package program for Windows. The mean, standard deviation, median, minium, and maximum were calculated for continuous variables. Count and percent were reported for categorical variables.

RESULTS

Between 2007 and 2013, 718 patients underwent open or arthroscopic shoulder surgery under combined ISB and GA. Out of 718 patients 65 patients received different approach for ISB and data of 12 patients were missing. Interscalene block was performed by Winnie approach in 641 patients who were included for assessment.

Interscalene block was applied preoperatively in all patients in the supine position with the head turned away from the side to be blocked. Following standard monitoring (ECG, Pulse oximetry and non-invasive blood pressure) and sedation (0.02-0.03 mg kg^{-1} midazolam and 1 µg kg^{-1} fentanyl), needle entry point was transdermally detected using the pen device (Stimuplex® Pen [STIMPEN] B. Braun Melsungen, Germany) of the nerve stimulator. The ISB was performed with Winnie approach, using a 22-gauge, 50 mm Stimuplex insulated needle (Stimuplex® D B. Braun Melsungen, Germany) and a nerve stimulator (Stimuplex® HNS12 Nerve Stimulator B. Braun Melsungen, Germany) (4). After the observation of deltoid muscle twitches between 0.2-0.5 mA of nerve stimulation, 30-40 mL of bupivacaine (0.375-0.5%) or levobupivacaine (0.375-0.5%) was injected in 5 mL increments following negative aspiration. The choice of the local anesthetic and the concentration varied depending on the preference of the anesthesiologist.

Patients were checked for the progression of the block with the pinprick test and after waiting for a period of approximately 20 minutes for the ISB to setle, they were taken to the operation room for the induction of GA. In all patients, general anesthesia was induced using propofol and rocuronium, and maintained with sevoflurane in 50:50 oxygen-air mixture. In case of an unsufficient nerve block and lack of proper analgesia during the surgery, IV infusion of remifentanil (0,1-0,2 µg kg^{-1} min^{-1}) was started. At the end of the operation in the recovery room, all patients with lack of analgesia were administered IV 0.1 mg kg^{-1} morphine. In the orthopedic ward, the time when the patient asked for an analgesic was recorded and 0.75 mg kg^{-1} intramuscular meperidine was administered.

The demographic variables and surgical procedures of the patients were summarized in Table I. The injected local anesthetic was bupivacaine in 268 (41.8%) and levobupivacaine in 373 (58.2%) of the patients.

The shortest and the longest analgesia times were found to be 0 and 24 hours respectively with a median value of 15.5 hours. Only 13 (2%) blocks were considered to have failed intraoperatively and required supplemental remifentanil infusion for the anesthesia. Furthermore in 10 (1.5%) patients the block was also considered to have failed as they required an additional analgesic in the recovery room. A total of 23 (3.5%) failed blocks were noted revealing a 96.5% success rate for the ISB.

Interscalene block related side-effects or complications of Horner's Syndrome, hoarseness and local anesthetic-related convulsion were observed in 124 (19.3%), 24 (3.7%) and 1 (0.2%) of the patients respectively (Table II). No permanent nerve injury attributable to ISB was observed in the study group either by the anesthesists or the orthopedists.

DISCUSSION

In recent years, ISB has been widely used in cases of shoulder arthroscopy and has been reported to have high success rates

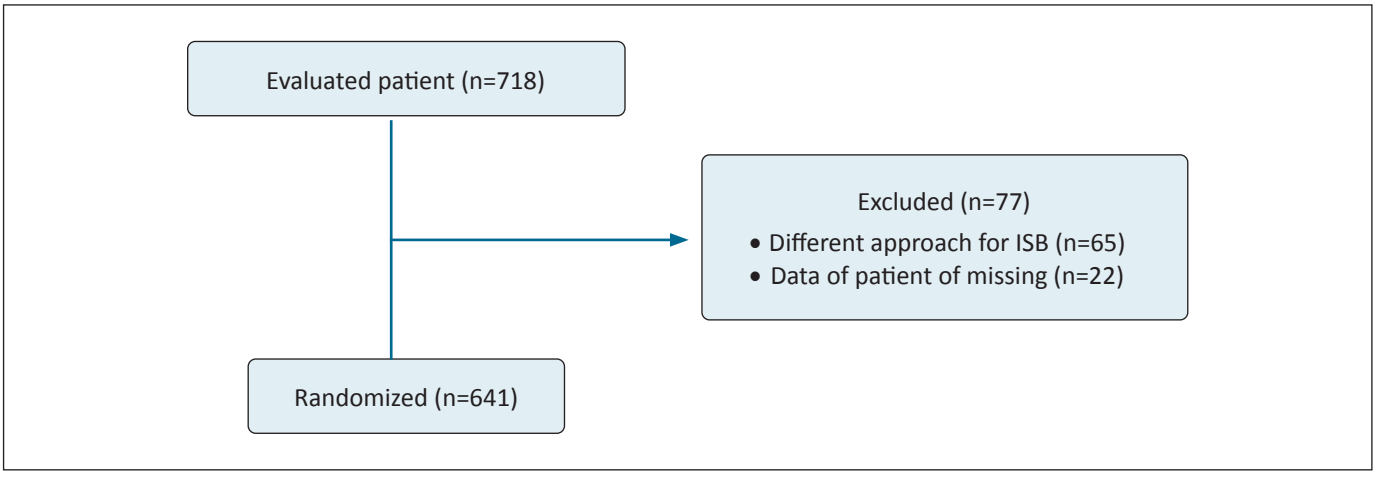

Figure 1. Consort diagram.

Table I. Patients Demographics and Types of Surgery

Gender, n (%)	
Female	373 (58.2)
Male	268 (41.8)
Age (years), Median (min-max)	49 (14-84)
Weight (kg), Median (min-max)	73 (50-118)
Height (cm), Median (min-max)	168 (149-190)
Surgical Procedures, n (%)	
Rotator cuff repair	323 (50.3)
Instability procedures	131 (20.4)
Isolated SLAP repair	95 (14.8)
Isolated subacromial decompression	92 (14.3)

Data are presented as n (%) and median (min-max) values
SLAP: Superior labral anterior to posterior tear.

Table II. Block Performance, Side Effects and Complications Rate

Success Rate, n (%)	618 (96.5)
Failed Blocks, n (%)	
Intraoperative ineffective anesthesia	13 (2)
Postoperative ineffective analgesia	10 (1.5)
Analgesia Time (hour), Median (min-max)	15.5 (0-24)
Side Effects/Complications, n (%)	
Hoarseness	24 (3.7)
Horner's Syndrome	124 (19.3)
Convulsion (LA intoxicity)	1 (0.2)
Permanent nerve injury	0

Data are presented as n (%) and median (min-max) values.
LA: Local anesthetic.

and low incidence of complications in experienced hands (5). The results of this retrospective study showed that the combination of ISB with general anesthesia provided both effective intraoperative analgesia reducing the need for opioids and also long-lasting postoperative analgesia. The result obtained of a 96.5% success rate from the ISB administered in this study, conforms with results in literature (6-12). While a generalised seizure associated with local anesthetic systemic toxicity (LAST) was observed in only 1 patient, no symptoms were seen which were thought to be related to permanent nerve damage in any patient. The low side-effect profile and high success rate obtained in this study can be considered to be related to all the blocks having been administered by two senior anesthesiologists experienced in peripheral nerve blocks. In addition, determination of needle insertion site by percutaneus electrical neurostimulation and observation of deltoid contraction under guidance of nerve stimulation are two important factors for success of procedure.

However, a clear point of criticism in this study is that although we performed a combined anesthetic approach, when success rates were compared, studies were taken into account, where ISB was the only anesthesia technique used and pain in response to the intraoperative surgical incision was evaluated as failure of the block.

In a study by Bishop et al. shoulder arthroscopy was applied under ISB to a series of 295 cases and the 96% success rate obtained was reported to be associated with the experience and ongoing training of the anesthetists, conformity of the surgeon and anesthetist and high patient compliance as they had been given detailed information about ISB preoperatively (6). Previously, there had been resistance to the application of regional anesthesia in shoulder surgery due to the potential complications of ISB and the likelihood of failed block. In a recent survey of the opinions of shoulder surgeons to ISB, it was reported that 76.1% of the surgeons recommended ISB to their patients and 73.7% declared ISB to be their preference if they themselves were to undergo shoulder surgery, thus revealing that the negative attitude of surgeons against regional anesthesia had receded (13).

Compared to GA, significant advantages have been reported to be obtained with ISB in shoulder arthroscopy, such as providing more effective postoperative pain control, a reduction in intra and postoperative opioid requirements, incidence of nausea and vomiting, nursing care and providing the possibility of day surgery by shortening the total hospital stay as well as the time in recovery room (6). However, sometimes because of reasons related to the intraoperative patient position, it is difficult to apply shoulder arthroscopy with ISB alone. Shoulder arthroscopy is applied with the patient in the lateral decubitus or beach chair position. In addition to anxiety which may be felt by an awake patient in the lateral decubitus position with the head near to the surgical area, the application of deep sedation to such a patient may create airway problems, so the use of ISB alone is limited (3,6). Although the main factor in the choice of position is the surgeon's experience, both positions have their own advantages and disadvantages. After the publication of reports of the development of neuropraxis in the brachial plexus due to traction in the lateral decubitus position, the beach chair position started to be more widely used (14). The beach chair position has significant advantages such as providing easier orientation with an upright anatomic position, facilitating examination under anesthesia with stabilisation of the scapula, providing a more dynamic view of the rotator cuff due to the mobility of the arm being operated on, easier transfer to open surgery and recognition of the possibility of operating under regional anesthesia (3). On the other hand, with shoulder surgery applied in the beach chair position, cerebral damage may develop because of air embolism or reduced blood flow in the vertebral artery associated with head manipulation (15). In addition, cases have been reported to develop brain and spinal cord damage, temporary loss of vision, ophthalmoplegia and death secondary to the development of deep hypotension in a sitting position (14,16). To avoid these serious side-effects, all the operations in the current study were performed in the lateral decubitus position as the choice of the orthopedic surgeon. After discussion of the difficulties which may arise from the application of shoulder arthroscopy to to an awake patient under ISB in the lateral decubitus position, the orthopedic and anesthesia teams reached a consensus to firstly apply ISB to all the cases and after checking the efficacy of the block to provide a combination with general anesthesia by intubation.

There are different views on the application of peripheral nerve block to patients under general anesthesia or heavy sedation at a level which will restrict patient co-operation (7, 17-19). In a retrospective analysis by Bogdanov and Loveland of ISB applied for shoulder arthroscopy to 548 cases under general anesthesia, no temporary or permanent neurological damage was observed (20). It was suggested that this high success rate was due to the application of all the blocks by experienced anesthetists and also to making a more caudal modification to the Winnie approach (4). Similarly, Misamore et al, reported only a 4% rate of persistent neurological symptoms in a prospective study where ISB was applied to patients under GA (7). As there was no randomisation nor any control group in this study, it is difficult to say whether the application of ISB after GA is either equivalent to or safer than the application of ISB before GA to support the results obtained. In contrast to these successful scenarios, Benumof suggested that general anesthesia should be accepted as a relative contra-indication for application of ISB after reporting 4 cases where total spinal anesthesia and permanent loss of cervical spinal cord function developed after ISB applied under general anesthesia (21). According to the Practice Advisory on Neurological Complications in Regional Anesthesia and Pain Medicine published by ASRA, it is recommended that apart from some cases such as those with dementia or retarded development, for which the cost benefit will be calculated, the application of peripheral nerve block in adult patients under GA or heavy sedation should be avoided. More specifically, under no circumstances is the application of interscalene block recommended for ISB to patients under GA or heavy sedation, including paediatric cases (17). As the most basic symptom of intraneural local anesthetic injection is the feeling of pain by the patient and the reaction of the body against pain, there can be considered to be increased risk in conditions such as general anesthesia or heavy sedation where communication between the patient and practitioner is restricted. Again in respect of intravascular injection, rapid recognition of the early signs of the LAST such as the metallic taste on the tongue, perioral numbness, tinnitus and changes in consciousness provides the anesthetist with the possibility of stopping the local anesthetic injection and thus injection of the remaining drug into the vascular area can be avoided. Indeed, in 1 patient in the current study, as alarm symptoms were noticed and communicated early, observed as a generalised convulsion associated with intravascular local anesthetic injection, the injection was stopped without administering more local anesthetic and thus the development of any complications which may have had a more serious result was prevented.

During the application of ISB, many side-effects or complications may be encountered (22,23). Among these are serious events such as phrenic nerve block, recurrent nerve palsy, bronchospasm, pneumothorax, Horner's syndrome, brachial plexus palsy or neuritis, permanent nerve injury, development of central block, permanent spinal cord damage, seizure and myocardial infarctus. In the current study, while most of the complications from this extensive list were not encountered, the most significant complication was the

development of a generalised seizure associated with LAST seen in 1 patient. Local anesthetic systemic toxicity which develops following ISB may be due to an accidental intravascular injection or absorption of the local anesthetic from the injection site, both resulting in an excess plasma concentration (24). Local anesthetic systemic toxicity findings may be observed as a cascade which can go from prodromal findings such as numbness around the mouth and a metallic taste to as far as seizure and cardiovascular collapse (25). This cascade, which develops depending on the rate of the increase in the blood levels of local anesthetic as a result of the systemic absorption, can not be observed after an intravascular injection which clinically causes a much more rapid progression (26). In addition, in a review of the published LAST cases in literature by Di Gregorio et al, seizure was reported as the most common symptom (27). The incidence of seizure in ISB cases has been reported at extremely low rates of 0.05%-0.7% (8,28). In a retrospective analysis by Rohrbaugh et al, of 15014 patients who underwent shoulder arthroscopy under ISB, it was reported that seizure associated with LAST developed in only 8 (0.05%) patients, which is a much lower rate than that obtained in the current study (8). The reason for this low rate is probably because some of the ISB applications were made under ultrasonography (USG) guidance. However, a significant point made in that study is that all the seizure cases developed during blocks applied without USG. It has been suggested that with USG, the needle can be visualised advancing in the tissue, intravascular injection can be prevented, and with the possibility of lower volume LA injection, the risk of LAST can be decreased (29). When USG is not available, a method should be applied to administer the lowest dose of local anesthetic, to inject the medication which is to be administered at 5 mL intervals, to make careful aspiration tests before each injection, to add an intravascular injection identifier such as epinephrine and to be very careful when working in areas of high vascularisation such as the interscalene area to prevent convulsions associated with local anesthetics.

Horner's syndrome is another complication that must be discussed. It is caused by an interruption of the oculosympathetic pathway, which can be induced by a variety of factors, and its clinical manifestations include ipsilateral blepharoptosis, pupillary miosis, and face anhidrosis (30). Horner's syndrome following ISB has been reported at a rate of 4-37.5% in the literature, depending on the regional anesthesia technique used, as well as the volume and dilution of the local anesthetic administered. It was discovered in 124 patients in our study at a rate of 19.3%, which is consistent with the literature. Stasiowski et al. reported that the volume, lipophilic potential and dilution of the local anesthetic solution used could be effective and that the USG-guided, peripheral nerve stimulation (PNS)-confirmed technique could reduce the incidence of Horner syndrome (31). On the other hand White et al. reported that the incidence of Horner's Syndrome was much lower in patients who underwent anterior suprascapular nerve block than in those who underwent ISB (32). Although our knowledge for the prevention of Horner's Syndrome is at the recommendation level, it should not be forgotten in terms of patient comfort to inform patients about this condition that may develop prior to beginning the application of peripheral block and to assure them that it is temporary.

The careful application and experience of the practitioners on the subject of ISB had an effect on the pleasing result of no permanent nerve damage developing in any case of the current retrospective evaluation. Limitations of the study can be stated as it being retrospective in nature and that patients could only be followed up as far as hospital discharge and with no protocol such as telephone follow-up, there was no possibility of recording any temporary nerve damage. Although on the postoperative 15th day no neurological complaints were found in the evaluation by the surgeon in the orthopaedic clinic, which indicated that there was no permanent nerve damage, that there could have been temporary nerve damage which had recovered, cannot be discounted. In a meta-analysis related to neurological damage observed after regional anesthesia, it was reported that in all peripheral nerve blocks, the possibility of the development of neurological damage was greatest after ISB at a rate of 2.84% (33).

In conclusion, with a profile of low side-effects and complications, providing a high level of patient satisfaction, the combination of ISB and GA can be recommended for use in arthroscopic shoulder surgery. The most important factors in obtaining this success can be considered to be the experience of the anesthetist, the careful application of the block and the close collaboration of the surgical team.

AUTHOR CONTRIBUTIONS

Conception or design of the work: IG, TZ
Data collection: GE, UK
Data analysis and interpretation: GE, TZ
Drafting the article: GE, IG, TZ, UK
Critical revision of the article: GE
Other (study supervision, fundings, materials, etc): GE, IG, TZ, UK
All authors (GE, IG, TZ, UK) reviewed the results and approved the final version of the manuscript.

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