Combined Interscalene Brachial Plexus Block and Bier's Block. Is it a solution for ulnar spare?

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Abstract

**Purpose:** Interscalene brachial plexus block (ISB) is a reliable and popular anesthetic modality with easy landmarks and avoid many complications of other blocks, but it is mostly associated with inconsistent blockade when it is used for forearm surgery because insufficient lower trunk block. We hypothesized that addition of Bier's block to ISB decrease the incidence of ulnar spare. This prospective double blind study was designed to evaluate the efficacy of combined ISB and Bier's block on forearm surgeries and its postoperative sequel.

**Patients and Methods:** One hundred and twenty patients were randomly allocated into two equal groups according to type of brachial plexus block (BPB); A supraclavicular (SCB) group (group I) and a combined interscalene (ISB) and Bier's block (Intra Venous Regional Anesthesia = IVRA) group (group II).
Both brachial plexus blocks (SCB&ISB) were performed then after establishment of adequate anesthesia for the arm, A tourniquet was applied to it in both groups then intravenous regional anesthesia (IVRA) with local anesthetic was performed in group II, while in group I an equal volume of normal saline was injected instead of the local anesthetic. Sensory and motor blockade degrees were evaluated in all patients of both groups after performing the block. Time to surgical anesthesia, adequacy of intraoperative anesthesia and post operative analgesia were recorded, also patients were observed for any side effects and asked for their all over satisfaction.

**Results:** Reduction in analgesic consumption and increase in block characteristics with more patient satisfaction were observed in combined ISB and Bier block more than SCB.

**Conclusion:** The addition of Bier's block to ISB offers an excellent and sufficient intraoperative sensory and motor blockade for the moderate time forearm surgeries making it comparable to SCB with a higher success rate, rapid onset and more patient satisfaction. Also it can be performed with low facilities conditions for perfect block such as ultrasound guidance.

**Keywords:** Interscalene, brachial plexus, Bier's, block, surgery and forearm

Introduction

Interscalene brachial plexus block (ISB) is considered a reliable anesthetic modality for upper arm surgery but it has a limitation when it is used for forearm surgery because sometimes it results in inconsistent blockade of the inferior trunk (C8-T1) of the plexus (1,2). Other common approaches to brachial plexus and regional blocks have different profile of results, advantages and disadvantages associated with each block e.g.; supravacuicular block carries a high risk of pneumothorax(3), infraclavicular block is infrequently practiced because of its technical difficulty(4) and axillary block do not provide an adequate anesthesia for the tourniquet pain (1) which also may associate Bier's block alone.
Consequently, some authors suggested a double block procedure (ISB) and axillary block to obtain more reliable anesthesia for shoulder and elbow surgeries (5). We hypothesized that combination of Bier's block which an easy technique to be performed especially with the routine use of tourniquet in most upper limb surgeries can be combined with ISB to decrease the incidence of ulnar spare and it would be less distressing to the patient and less time consuming than other double brachial plexus block techniques, concerning the maximum allowable total dose of local anesthetic drugs used.

This prospective comparative study was designed to evaluate the efficacy of combined ISB and Bier's block on forearm surgeries and its postoperative sequel versus the SCB alone which considered approximately, the most reliable brachial plexuses technique that covering both proximal arm (site of tourniquet applied to most of upper limb surgeries especially orthopedic surgeries) and distal forearm (site of surgical interference).

Patients and Methods

This prospective randomized double blind study was approved by the local ethical committee and informed written consent was signed from all patients. One hundred twenty adult patients of both sex, ASA (I-II), age 18-65 years, scheduled for elective forearm, elbow or distal humorous surgeries were planned for the study at Mansoura...
University Hospital from December 2010 to December 2013. A thorough pre-anesthetic evaluation was done prior to surgery. Patients with previous history of central or peripheral neurological diseases, coagulopathy or anticoagulant therapy, sickle cell disease, Raynoud's disease, liver disease, kidney disease, contralateral recurrent and/or phrenic nerve paresis and those unable to cooperate were excluded. Patients with a known allergy to any of the study drugs and patients in whom surgery lasted more than 90 minutes were also excluded from the study.

At the preanesthetic room, all patients were evaluated prior to the surgery. The baseline pin prick score was analyzed by using a 25 G. sterile needle at the arm, forearm or hand with intact skin on a three point scale (2= normal sensation, 1= blunted sensation and 0= absence of sensation). Also the 11 point, 100 mm visual analog scale (VAS) was shown to all patients and they were made familiar with it.

Monitoring of heart rate, non invasive blood pressure, respiratory rate, electrocardiogram (ECG) and peripheral oxygen saturation (spO2) were continued throughout the procedure.

After a computerized randomization and a closed envelope technique, all patient were allocated into one of two groups according to the technique used, each include 60 patients:

1. Supraclavicular brachial plexus block (SCB) group (group I)
2. Combined interscalene brachial plexus block (ISB) and Bier's block (group II)

In the operating room, a single anesthesiologist well qualified and familiar with brachial plexus block techniques performed the blocks including Bier's block (6) then a highly trained anesthesia nurse, blind to the techniques used, was involved in follow up and monitoring of different parameters of the study both at intraoperative and postoperative periods.

After an eight hours fasting period, a 5 mL·kg⁻¹ crystalloid fluid infusion was given via a venous access to the non-surgical hand while another cannula (22 G) was applied to the hand of the injured limb and spared for LA admistration.

All patients were sedated with midazolam 0.02 mg/Kg and fentanyl 1 µg/Kg before performing anesthesia and no other sedation was administered until the evaluation of the block was completed then;

In the SCB group (group I):

After identifying the lateral head insertion of the sternocleidomastoid muscle to the clavicle, about 2.5 cm lateral to the sternocleidomastoid, at this point and above the palpating finger about 1 cm above the clavicle, the stimulating needle attached to a nerve stimulator was inserted perpendicularly to all the skin planes and slightly caudally, while motor response is tested at a current of 0.8~1.0 mA in the distal forearm in the form of finger twitches then 40 mL of local anesthetic mixture containing 0.5% bupivacaine and 1% lidocaine 1:3 volume with 1:200,000 epinephrine and sodium bicarbonate 4.2% was added in the ratio of 1ml to 10ml local anesthetic solution was injected slowly with intermittent negative aspiration and motor response diminution evaluated with end of injection.

In the ISB group (group II):

A 22 gauge, 50 mm stimulating needle attached to a nerve stimulator (Stimuplex, B. Braun Melsungen Germany) was inserted in the interscalene groove at the level of C6. The needle was advanced perpendicularly to all the skin planes, while motor response in the arm muscles (biceps or deltoid) and pectoralis were tested at a current of <0.5 mA. With the appearance of appropriate motor response the same dose as that of SCB was injected slowly with intermittent negative aspiration and pressure was applied during injection to direct the spread of LA caudally and preventing cephalic migration.

For both groups:

1. Sensory block was evaluated by pin prick every 5 minutes for 15 minutes after then a resting period of 20 minutes till the sensory block was complete.

For both groups:

1. Motor block was assessed by the patient to abduct/adduct the thumb (radial/ulnar nerve) to oppose the thumb (median nerve) and to flex the elbow (musculocutaneous nerve). The onset time of motor block was recorded when the patient became unable to move the fingers. The patient quantified the quality of the block (sensory or motor) using any score between 0 and 2, with 0 representing no block, 1 representing partial block and 2 representing complete block.

When obtaining inadequate sensory block at the level of the arm, a tourniquet cuff was applied to the arm of injured limb then it was simply elevated and decongested by wrapping it with a bandage, beginning distally and squeezing toward the heart. The tourniquet cuff was inflated to at least 100 mmHg above the patient's systolic pressure for a minimum of 30 minutes and no longer than 90 minutes. The bandage was removed and the IVRA was performed by injecting 30:40 mL of lidocaine 0.5% with 3 mg morphine (7) in group II, while in group I; A same volume of normal saline was injected instead of the local anesthetic in the cannula of the injured limb which then removed from all patients of both groups.

The sensory and motor characteristics of each group evaluation was continued and recorded as before up to complete sensory and motor block. Surgical anesthesia, surgery without patient discomfort or the need for local or general anesthesia supplementation of the block, was recorded. Intraoperative sedation was established when needed by a propofol infusion titrated up to 50 µg/Kg /min.to maintain constant verbal contact with the patient, if the patient needed more than 50 µg/kg/min of propofol to complete surgery, the block was considered as failed block and general anesthesia was administered.

Recovery from sensory block was assessed by the pin prick method every 5 minutes after tourniquet release till the pin prick score returned to normal baseline value along all nerve tributaries, this time interval was taken as the sensory block recovery time. Also the time of regression of motor block was assessed recorded at the same time intervals till full motor block recovery (movement of fingers, wrist, elbow and shoulder).

In the postoperative period monitoring of the patients at the 1st 24 hours for pain also by a research nurse who was not involved in the study. Sensory and motor block...
The proportion of patients with complete blocks in both groups at 30 min (table 2) did not show statistically significant difference for any nerve tributary distribution between the two groups. Ulnar block quality in group II was comparable to that of group I and superior to it (100% versus 94%) of patients respectively. Figure 1, showed the progression of the allover block against time for each group with a relatively earlier and sharper slope to a higher level of blocks in group II and this was mildly after administration of IVRA.

All patients were observed for the duration they remained pain free postoperatively, this was noted as the time to first analgesic request which did not statistically change between the two groups however it was mildly prolonged in group I.

We did not encounter any serious side effects of any of the techniques used but two patients in group I and four patients in group II suffered from mild hypotension which needs no treatment except IV infusion of 500 cc lactated Ringer’s solution (table 4). The patient satisfaction was statistically increased in group II compared with group I (table4).

Table 1: Demographic data, type of surgery and number of patients with block failure of the studied groups.

<table>
<thead>
<tr>
<th>Patients Characterizations</th>
<th>Group I N=54</th>
<th>Group II N=58</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender(M/F )No.</td>
<td>34/20</td>
<td>39/19</td>
</tr>
<tr>
<td>Age(Mean±SD)</td>
<td>40.2±14.6</td>
<td>43.4±12.1</td>
</tr>
<tr>
<td>Weight(kg)(Mean±SD)</td>
<td>74.5±6.2</td>
<td>78.4±5.6</td>
</tr>
<tr>
<td>Height(cm)(Mean±SD)</td>
<td>161.8±3.2</td>
<td>164.6±7.1</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Duration of operation(min)(Mean±SD)</td>
<td>87.2±11.5</td>
<td>91.3±14.6</td>
</tr>
</tbody>
</table>

**Type of surgery:**

<table>
<thead>
<tr>
<th></th>
<th>Group I N=54</th>
<th>Group II N=58</th>
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</thead>
<tbody>
<tr>
<td>Open reduction and internal fixation</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>Plate removal(No.)</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>Tendon repair(No.)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Soft tissue surgery(No.)</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2: The proportion of patients with complete blocks in both groups at 30 min. (For each nerve tributary and the overall block).

<table>
<thead>
<tr>
<th>Nerves</th>
<th>Group I N=54</th>
<th>Group II N=58</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumflex nerve</td>
<td>92%</td>
<td>99%</td>
<td>0.08</td>
</tr>
<tr>
<td>Musculocutaneous nerve</td>
<td>93%</td>
<td>97%</td>
<td>0.10</td>
</tr>
<tr>
<td>Median nerve</td>
<td>94%</td>
<td>100%</td>
<td>0.09</td>
</tr>
<tr>
<td>Radial nerve</td>
<td>93%</td>
<td>100%</td>
<td>0.08</td>
</tr>
<tr>
<td>Ulnar nerve</td>
<td>94%</td>
<td>100%</td>
<td>0.09</td>
</tr>
<tr>
<td>Overall block</td>
<td>93.2%</td>
<td>99.2%</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Table 3: Block characteristics.

<table>
<thead>
<tr>
<th>Block characteristics</th>
<th>Group I N=54</th>
<th>Group II N=58</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset of sensory block (sec)</td>
<td>299.20±23.10</td>
<td>238.23±41.54*</td>
<td>0.001</td>
</tr>
<tr>
<td>Recovery from sensory block (min)</td>
<td>189.52±0.72</td>
<td>194.21±0.34</td>
<td>0.317</td>
</tr>
<tr>
<td>Onset of motor block (sec)</td>
<td>305.10±22.13</td>
<td>240.13±31.21*</td>
<td>0.001</td>
</tr>
<tr>
<td>Recovery from motor block (min)</td>
<td>192.12±0.88</td>
<td>186.34±0.72</td>
<td>0.326</td>
</tr>
<tr>
<td>Time to 1st analgesic request(min)</td>
<td>289.51±0.32</td>
<td>270.60±0.13</td>
<td>0.242</td>
</tr>
<tr>
<td>Number of analgesic doses at the first 24 h</td>
<td>1.55±0.40</td>
<td>1.65±0.21</td>
<td>0.903</td>
</tr>
</tbody>
</table>

* Significant when compared to the other group.

Table 4: Side effects in each group.
Discussion
To our knowledge, there are no published reports on combined interscalene block and Bier’s block for forearm surgery. This study demonstrated that combined ISB with Bier’s block resulted in greater frequency of sensory and motor blocks of the forearm compared with SCB alone. The conventional approach to ISB at the C6 level may result in delayed or frequently absent blockade of the lower trunk of the brachial plexus (C8, T1: ulnar nerve) in up to 50% of blocks leading to inadequate anesthesia along the medial aspect of the forearm and hand. The use of double brachial plexus block is time consuming, possibly uncomfortable to the patient and potentially associated with either increased failure rate may be due to it implies using less local anesthetic solution on each technique (8) or increased the risk of side effects and local anesthetic systemic toxicity(9) which is not the condition with bier’s block as the tourniquet used delayed the release of LA to the circulation which already calculated not to exceed the allowable safe pharmacological dose and assure full even distribution of LA all over the isolated limb mass. So, the choice to perform Bier's block on the same side of ISB would cover the ulnar spare of ISB and provide a reliable anesthesia to the forearm (10), including the ulnar side by block of small nerves or possibly nerve endings and not the major nerve trunks, explaining both rapid onset and high success rate of this technique (11, 12) compared with SCB alone.
Mohr reviewed 1816 forearm injuries over 5 years period under Bier's block, he reported 99.5% success rate with no
cases of mortality or serious morbidity except 0.5% associated with complications attributed to cuff leaks(13). On evaluating complete anaesthesia of all target nerves, the proportion of blocks in the present study in which all tributaries were completely anaesthetized at 30 minutes was greater than previous study done by Kim and his colleagues(1). This may be explained by slightly faster completion times resulting from the larger proportion of lidocaine in the anesthetic mixture used in the present study (lidocaine & bupivacaine), while kim and his friends used mepivacaine and ropivacaine mixture. In the present study, sodium bicarbonate was added to increase the speed of onset of blockade (5). Block quality (partial or complete block of all nerve tributaries) was clinically observed better in group II than group I but not statistically significant, because no nerve terminals spared from IVRA in group II which start with a dense block and more slopping onset once it was applied (Table 2) (figure 1).

In this study, no serious side effect was observed such as convulsion in both groups. This may be explained by injection of total dose of local anesthetic was over an extended period of time, the use of arm tourniquet and drugs used for sedation. In consistence with our finding Maurer and his colleagues who reported that propofol decreased the rate of development of local anesthetic toxicity when added to patients with interscalene and infraclavicular block for bilateral distal radius fracture (14). In conclusion, the addition of Bier’s block to ISB offers an excellent and sufficient intraoperative sensory and motor blockade for the moderate time forearm surgeries making it comparable to SCB but with a higher success rate, rapid onset and more patient satisfaction. Also it is an easy technique can be performed with low facilities conditions for perfect block such as ultrasound guidance.

References
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