

# COMPARE THE EFFICACY AND SAFETY OF COMBINED SUPERFICIAL AND DEEP CERVICAL PLEXUS BLOCK IN CAROTID ENDARTERECTOMY PATIENTS USING ULTRASOUND GUIDANCE AND LANDMARK TECHNIQUE WITH THE GENERAL ANAESTHESIA TECHNIQUE

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## ABSTRACT

### BACKGROUND

Carotid endarterectomy remains the gold standard in both symptomatic and asymptomatic carotid artery occlusive disease<sup>1</sup> which can be performed either under general anaesthesia or regional anaesthesia using ultrasound guidance or landmark technique. We wanted to study the role of ultrasound in cervical plexus block as there has been no published work in the arena of ultrasound guided blocks in CEA. The main objective of the study is to compare the efficacy and safety of combined superficial and deep cervical plexus block in carotid endarterectomy patients using ultrasound guidance and landmark technique with general anaesthesia technique in terms of the local anaesthetic used for the block, supplemental local anaesthetic infiltration by the surgeons, patient and surgeons satisfaction, anaesthesia conversion rate in regional block, analgesic requirements intraoperatively, perioperative complications, hemodynamic instability and cost.

### METHODS

40 patients of ASA physical status II and III were operated between July 2010 and December 2013 at our Institute. Retrospective analysis of patient characteristics, anaesthetic technique and perioperative events was performed and the benefits of using ultrasound for cervical plexus block (CPB) were observed. Statistical Analysis of the data obtained was done using SPSS version 20 for Windows.

### RESULTS

The dose of local anaesthetic bupivacaine was 85mg in ultrasound blocks and 105mg in landmark guided technique. 95.2% patients in ultrasound group had good muscle relaxation Grade 3 as described by surgeons and only 37.5% patients in landmark technique were relaxed well. None of the patients in ultrasound technique had requirements of additional local anaesthetic supplementation during surgery as compared to 62.5% patients in landmark group who required additional LA infiltration. Conversion rate to general anaesthesia was 4.7% in ultrasound group in contrast to 12.5% in landmark group.

### CONCLUSIONS

Ultrasound guided superficial and deep cervical plexus block is more efficacious and safer than surface landmark technique in carotid endarterectomy surgery as there is reduction in local anaesthetic dose, no requirement of additional lignocaine infiltration, less conversion rate and perioperative complications, good patient and surgeon satisfaction and cost effective, under skilled and experienced anaesthesiologist.

### KEYWORDS

CEA- Carotid Endarterectomy, Regional Block, Cervical Plexus Block, General Anaesthesia

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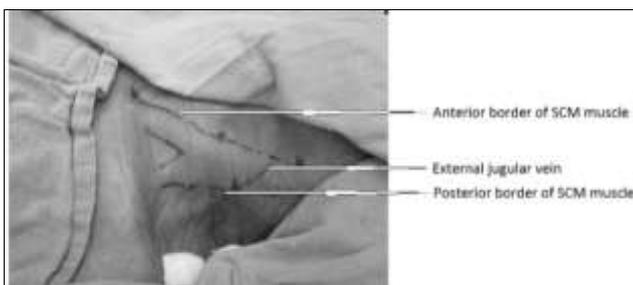
### BACKGROUND

Carotid endarterectomy remains the gold standard in both symptomatic and asymptomatic carotid artery occlusive disease. In symptomatic patients, carotid endarterectomy is performed in stenosis of carotid artery ranging from >70% single focal TIA or stroke to < 30% stenosis with or without ulcer whereas in asymptomatic patients, surgery is performed in arterial stenosis ranging from > 70% to > 50% stenosis with large ulcer. Operative morbidity and mortality rate for this indication should be less than 3%.<sup>1</sup> Carotid endarterectomy (CEA) surgery can be performed either under general anaesthesia or regional anaesthesia. Although

regional anaesthesia has been preferred in high risk patients as it avoids the systemic complications of general anaesthetic technique,<sup>2</sup> the recent international, multicentre GALA trial<sup>3</sup> failed to demonstrate superiority of the regional technique probably because the precise technique of regional anaesthesia was not tightly controlled. Hence, we designed our own unique way of giving combined superficial and deep cervical plexus block using ultrasound guidance after studying sonoanatomy of the neck as there is no evidence or published literature on use of ultrasound especially in deep cervical plexus block. The incorporation of ultrasound guidance to allow for precise control of local anaesthetic spread has undoubtedly allowed this to flourish in the anaesthesia community. There is an ever-expanding view that incorporation of ultrasound guidance into placement of regional blocks increases safety and speed and decreases complications and overall volumes of local anaesthetic use. In view of the above advantages, this study was conducted to prove the beneficial role of ultrasound guided cervical plexus block over landmark and general anaesthesia technique.

The main objective of the study is to compare the efficacy and safety of combined superficial and deep cervical plexus blocking carotid endarterectomy patients using ultrasound guidance and landmark technique with the general anaesthesia technique in terms of the local anaesthetic used for the block, supplemental local anaesthetic infiltration by the surgeons, patient and surgeons satisfaction, anaesthesia conversion rate in regional block, analgesic requirements intraoperatively, perioperative complications, hemodynamic instability and cost. Retrospective study was conducted in 40 patients of ASA PS II and III undergoing carotid endarterectomy from July 2010 to December 2013 at our Institute of Anaesthesiology and Critical Care at Medanta, the Medicity using a protocol approved by the institutional review board. Patients undergoing CEA under regional or general anaesthesia technique, ASA PS II and III, either gender, BMI < 40kg/m<sup>2</sup> were included in the study. Patients with known bleeding diathesis, local sepsis, chronic pulmonary disease, history of allergy to local anaesthetic agents, known diaphragmatic motion abnormalities, localised obesity in the neck (neck circumference 60 cm or greater) were excluded from the study.

## METHODS



**Figure 1. Skin Markings for Reference During Probe Placement**

All CEAs were performed by the same three senior vascular surgeons who were blinded to the technique of regional anaesthesia used and all anaesthesiological procedures were conducted by experienced anaesthesiologists. After thorough pre-anaesthetic evaluation and written informed consent, patients who had opted for cervical plexus block under ultrasound guidance or landmark technique were explained about testing their speech, cerebation and motor power during the surgery as early measures of inadequate cerebral perfusion. All patients were premedicated with 0.25 mg oral alprazolam and 40 mg oral pantoprazole on the night and morning of surgery. On the day of surgery, patients were shifted to operation theatre, standard monitors were connected, 5 lead ECG, non-invasive blood pressure, pulse oximeter, end tidal CO<sub>2</sub>, 20 G invasive radial arterial line, axillary temperature probe prior to block or induction. 5 l/min O<sub>2</sub> via face mask was administered to patients for cervical block. Patients were positioned supine on the O.T table with the neck turned to the other side. Anaesthesiologist stand on the side of the prepared neck. Linear, high frequency ultrasound probe was used for the cervical block. Parts were prepared with betadine and spirit. Superficial cervical plexus block is situated outside the prevertebral fascia of neck and most of the cutaneous nerves exit posterior of the midpoint of sternocleidomastoid. It originates from deep cervical plexus which originates from anterior rami of C1-C4 cervical nerves. Deep cervical plexus is located below pre vertebral fascia in paravertebral space at the level of C1-C4 cervical nerves and innervates deep muscle.<sup>4</sup> Echotexture of proximal nerve is different from echotexture of distal nerve. Roots of deep cervical plexus are black, look similar to blood vessels whereas distal peripheral nerve are white. For superficial cervical plexus block, in an in-plane technique, ultrasound probe is held at the midpoint of the posterior border of sternocleidomastoid muscle wherein the posterior belly of muscle is identified. As the posterior triangle of the neck was scanned, the anatomic level of the levator scapulae muscle below the sternocleidomastoid muscle, the fascial band between the sternocleidomastoid and the levator scapulae muscles and the third cervical transverse process were visualized.<sup>5</sup> Colour Doppler was also used to locate the vertebral vessels. 3 ml of 0.25% bupivacaine is injected in the subcutaneous plane superficial to muscle and 5 ml of 0.25% bupivacaine is infiltrated in the fascial plane (formed by the fusion of investing fascia and prevertebral fascia) between the sternocleidomastoid and the levator scapulae muscles. We usually cannot visualize superficial cervical plexus with ultrasound, but we can see the deep fascia and sternocleidomastoid above it and can hydro-dissect the appropriate fascial plane with local anaesthetic.

For deep cervical plexus block, anterior border of sternocleidomastoid is identified, 1-2 cm above the midpoint towards the mastoid, the needle is advanced between the levator scapulae and the hyperechoic contour of the cervical transverse processes and 5 ml of 0.5% bupivacaine is given between 12 o' clock and 3 o' clock position to carotid artery and 5 ml of 0.5% bupivacaine is administered 1-2 cm

below mid-point at the same level. Hence, local anaesthetic is injected in the cervical paravertebral space which bathes the carotid sheath and blocks deep cervical plexus.<sup>6</sup> 6 ml of 0.25% bupivacaine is injected subcutaneously on the anterior border of sternocleidomastoid extending from thyroid cartilage distally to the suprasternal notch to block the branches crossing from the opposite side. Total of 34 ml of 0.25% bupivacaine was used in ultrasound guided technique whereas 42 ml of 0.25% bupivacaine was used in landmark technique. 15-20 minutes after the block was placed, skin testing to pinprick and cold was performed according to standard dermatome charts by an anaesthesiologist. All the ultrasound guided blocks were given in first attempt while the surface landmark technique required a few attempts.

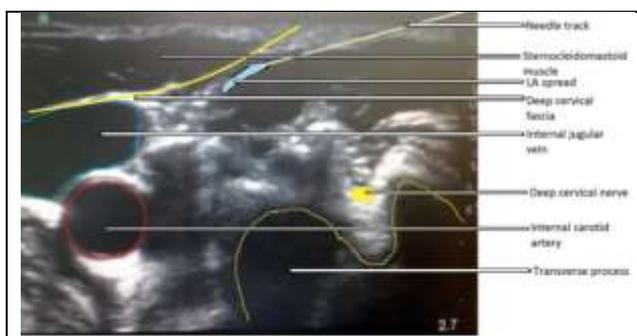


Figure 2. Superficial Cervical Plexus Block Site

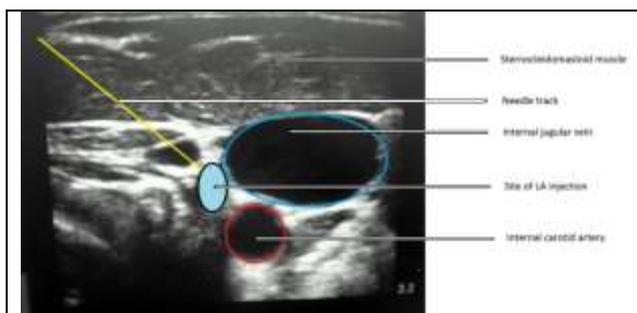


Figure 3. Sono-Image of the Injection Point for Sheath Block

Patients' in general anaesthesia group were induced with 1 mg I.V. midazolam, 2 µg/kg I.V. fentanyl, 1-2 mg/kg I.V. propofol and 0.1 mg/kg I.V. vecuronium. Anaesthesia was maintained with 1 MAC isoflurane in 40% oxygen in air by controlled ventilation via circle system with 8- 10 ml/kg of tidal volume, respiratory rate adjusted to maintain ET CO<sub>2</sub> of 35-40 mmHg. Patients' were reversed with 0.05 mg/kg I.V. neostigmine and 0.01 mg/kg I.V. glycopyrrolate and smoothly extubated at the end of procedure. Special neurological monitoring was not used in any of the general anaesthesia patients.

Rescue analgesia with opioids were administered depending on the patients' requirement. Surgeons were blinded to the type of block used. Additional local anaesthetics were administered superficially or deep by the surgeon in 1 ml aliquot to supplement the block whenever the patient reported discomfort. The surgeon rated the operative exposure in terms of muscle relaxation on a four-

point subjective scale as 0= none, 1= poor, 2= moderate, 3= good. Complications such as need to convert to general anaesthesia, use of shunt, any perioperative cardiac, neurological, hemodynamic or respiratory complications, puncture of vertebral artery, intrathecal injection or seizures were noted. Other parameters like duration of surgery, clamp time and cost effectiveness were also studied.

**RESULTS**

Statistical analysis of the data obtained was done using SPSS version 20 for Windows (copyright SPSS Inc., Chicago, U.S.A.). For all tests in study, P <0.05 was considered significant, P <0.005 was considered highly significant and P >0.05 was considered insignificant. Patients' demographic data comprising of severity of disease, age, BMI, gender and sex are similar in both the groups.

Extent of Carotid Stenosis of Either Side	Number of Patients (n)
< 90% stenosis	11
≥ 90% stenosis	29
Total	40

Table 1. Severity of Disease

Gender	Number of Patients (n)
Male	28
Female	12
Total	40

Table 2. Gender Demographics

	Mean ± Standard Deviation
Age in years	66.7 ± 10.25
BMI (kg/m <sup>2</sup> )	25.2 ± 4.3

Table 3. Age (Years) and BMI (kg/m<sup>2</sup>)

		General Anaesthesia (n) (%)	Regional Anaesthesia (n) (%)
1.	Number of patients	13	27
2.	Technique of cervical plexus block		Ultrasound- 21(77.7%) Landmark - 8(29.6%)
3.	Local anaesthetic dose (Bupivacaine) in mg		Ultrasound- 85mg Landmark- 105mg
4.	Use of carotid shunt (n)	13(100%)	7(25.9%)
5.	Number of patients with Grade 3 muscle relaxation of operative site (n)	9(69.2%)	Ultrasound-20 (95.2%) Landmark- 3(37.5%)
6.	Use of additional local anaesthetic infiltration by surgeon (n)	1(7.7%)	Ultrasound- Nil Landmark- 5(62.5%)
7.	Use of vasopressors (n)	4(30.8%)	Ultrasound-3(14.2%) Landmark-2(25%)
8.	Use of intraoperative analgesics (n)		5(18.5%)
9.	Conversion to GA		Ultrasound-1(4.7%) Landmark-1(12.5%)

Table 4. Results

	Intraoperative	Postoperative
General Anaesthesia	Hypotension n=4	
	Hypertension n=2	
	Bradycardia n=1	
Regional Anaesthesia	Hypotension n=2	Hoarseness n=1
	Hypertension n=2	Neck Hematoma n=2
	Seizure n=1	Failed block in landmark group-1

Table 5. Complications

In our retrospective study, 40 patients' data were studied out of which 13 patients had undergone CEA under general anaesthesia and 27 patients' were under regional anaesthesia group. Out of 27 patients' under regional

anaesthesia, 21 were performed under ultrasound guided block and 8 were under landmark technique. The dose of local anaesthetic bupivacaine was 85mg in ultrasound blocks and 105mg in landmark guided technique. 95.2% patients in ultrasound group had good muscle relaxation Grade 3 as described by surgeons' and only 37.5% patients in landmark technique were relaxed well. None of the patients in ultrasound technique had requirements of additional local anaesthetic supplementation during surgery as compared to 62.5% patients in landmark group who required additional LA infiltration. Carotid shunt was used in all general anaesthesia patients whereas in only 25% of regional anaesthesia group. 6 patients' in general anaesthesia had hemodynamic instability whereas only 4 patients in regional group had hemodynamic perturbations. 2 patients in cervical plexus block were re-explored for development of neck hematoma postoperatively. 2 patients in regional anaesthesia group were converted to general anaesthesia, 1 in landmark technique due to failed block and another in ultrasound group due to seizures. Conversion rate to general anaesthesia was 4.7% in ultrasound group in contrast to 12.5% in landmark group.

## DISCUSSION

Carotid endarterectomy (CEA) can be performed either under general anaesthesia or combined superficial and deep plexus block using ultrasound guidance or landmark technique. The efficacy of regional block is determined by the volume of local anaesthetic used, additional local anaesthetic supplementation by surgeons, surgeon satisfaction in terms of good relaxation of operative site and patient satisfaction, conversion rate to general anaesthesia, use of intraoperative analgesics and technique of using ultrasound. Our study is one of the first kind where we have used ultrasound in CEA cases to block both superficial and deep cervical plexus. Total volume of 34 ml of 0.25% bupivacaine is used in ultrasound technique and 42 ml of 0.25% bupivacaine in landmark technique by anaesthesiologist which may or may not have been supplemented with additional doses of 1% lignocaine by surgeons during surgery depending on their and patient satisfaction. None of the studies till date have described the exact volume of local anaesthetic used for the block. There is reduction in dose of local anaesthetic in ultrasound group. In a prospective, randomized study of comparison of deep or superficial cervical plexus block for carotid endarterectomy by Mark D. Stoneham,<sup>7</sup> there were no differences in terms of supplemental local anaesthetic requirements, although this is influenced by whether paraesthesia is elicited during placement of the deep block. This is in contrast to our study where in ultrasound group, none of the patients required any additional lignocaine supplementation while 62.5% patients in surface landmark technique required infiltration with 1% lignocaine which is clinically significant. Surgeons satisfaction was good (Grade 3) in 69.2% patients under general anaesthesia while 95.2% patients in ultrasound and 37.5% patients in surface landmark group were well relaxed.

In the study by J.J. Pandit et al,<sup>2</sup> complications related to superficial and deep cervical plexus block using landmark technique were studied where it was found that deep/combined block was associated with higher serious complication rate related to the injecting needle when compared with superficial block. Conversion rate to general anaesthesia was also higher with deep/combined block but there was an equivalent incidence of other systemic serious complications. The most common reasons to convert to general anaesthesia were block failure, accounting for 40% (all of which occurred with deep block, 69 conversions) and patient anxiety or lack of co-operation, accounting for 45%. In our study conversion rate to general anaesthesia in ultrasound group is just 4.7% and 12.5% in landmark group. There was only 1 patient in ultrasound group which was converted due to seizures and 1 patient in landmark technique which was converted due to block failure. We had excluded patients who were not co-operative for regional anaesthesia group. None of the patients had serious systemic complications like TIA or cardiovascular event. It is not justifiable to combine the results of different studies which had different primary end-points but it was still brought up in the article to highlight the decreased conversion rate in our study perhaps firstly, due to the intervention of ultrasound.<sup>8</sup> The major complication of the cervical plexus block is inadvertent deep injection of local anaesthetic leading to blockade of the deeper neural structures including the phrenic nerve, brachial plexus, the recurrent laryngeal nerve, puncture of external jugular vein and carotid artery. In our experience, this complication is easily avoided through standard block precautions, most importantly only injecting local anaesthetic when there is direct visualization of the needle tip.<sup>9</sup> The key to successful regional anaesthesia is deposition of LA accurately around the nerve structures. Whenever injecting local anaesthetics, there is the risk of intravascular injection and resulting toxicity.<sup>10</sup> Secondly, as deep block is technically more challenging, it was performed by the same skilled and experienced anaesthesiologist for all the CEA cases.

In a study by Marco Barone et al,<sup>11</sup> where carotid endarterectomy was performed with intermediate cervical plexus block, conversion rate was only 2%. Low conversion rate when using an intermediate approach seems to contradict the conventional belief that a deep cervical plexus block produces a complete block and improves intraoperative muscle relaxation, therefore resulting in a greater success rate than that of a purely superficial cervical plexus block.<sup>12</sup> Studies by Chan et al<sup>13</sup> and Pearlas et al<sup>14</sup> revealed that ultrasound group as compared to nerve stimulation group had significantly higher block success rate, faster onset and progression time without an increase in block procedure time or complications. Results from the above mentioned studies instigated us to design our present study to compare the efficacy and safety of combined superficial and deep cervical plexus blocking ultrasound and surface landmark group in CEA patients.

Use of intraoperative analgesics was limited to only 18.5% of regional anaesthesia patients. Carotid shunt was

used in 100% general anaesthesia patients and 25.9% in regional anaesthesia patients. Ultrasound is more efficacious than surface landmark due to direct observation of nerves,<sup>15</sup> direct observation of surrounding structures (vessels, muscles, tendons), facilitating the identification of nerves,<sup>16</sup> direct observation of LA deposition and spread,<sup>17</sup> avoidance of painful evoked muscle contractions,<sup>18</sup> decrease in complications such as accidental intraneural or intravascular injection,<sup>19</sup> faster onset of block, longer duration of block, improved block quality and decreased dose of LA.<sup>20</sup> Blind techniques relying on pops, clicks, twitches and the need for multiple trial and error needle passes, with their lack of accuracy, reliability, longer placement times, patient discomfort and injury. Landmark techniques have variations in anatomy<sup>21</sup> and nerve physiology<sup>22</sup> as well as equipment accuracy which have adverse effects on success rates and complications. Safety of the study is analysed by complication rate and the technique used for the block. 46.1% patients in general anaesthesia and 14.8% in regional group had hemodynamic instability. Two patients in regional anaesthesia were re-explored for neck hematoma post operatively. Two patients were converted to general anaesthesia due to seizures and failure of block. Ultrasound adds to the safety as it is clinically effective, practical and cost effective.

Regional anaesthesia is presumed to offer advantages over general anaesthesia in terms of monitoring neurological function during cross clamping of the carotid artery since, in conscious patients, speech, cerebration and motor power provide early measures of inadequate cerebral perfusion<sup>2</sup> when we are not using special neurological monitoring. Some studies also claim lower shunting requirements, lower cardiovascular morbidity and shorter hospital stay.<sup>23</sup>

## CONCLUSIONS

Regional anaesthesia is preferred to general anaesthesia in carotid endarterectomy surgery as awake and conscious patient is the best neurological monitor, lowers shunting requirements, and lowers cardiovascular morbidity. It is concluded from our study that ultrasound guided superficial and deep cervical plexus block is more efficacious and safer than surface landmark technique in carotid endarterectomy surgery as there is reduction in local anaesthetic dose, no requirements of additional lignocaine infiltration, less conversion rate and perioperative complications, good patient and surgeon satisfaction and cost effective under skilled and experienced anaesthesiologist. Both the surgeon and anaesthetists are blinded, additional local anaesthetic supplementation only when episodes of discomfort were present, and doses of analgesics were modest and unlikely to influence the results.

## Limitations

It is a retrospective study, sample size is small, and it lacks randomization. Strengths of the study are

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