Intermediate Cervical Plexus Block for Carotid Endarterectomy: A Case Series of the Spread of Injectate

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Abstract

Background: The case series illustrates the spread of local anesthetic resulting from a standardized single-injection technique of intermediate cervical plexus block before carotid endarterectomy.

Methods: 14 consecutive patients scheduled for elective carotid endarterectomy were included. Standardized intermediate cervical plexus block was performed on the level of C5/C6 at the posterior border of the sternocleidomastoid muscle. A mixture of 20ml Ropivacaine 0.75%, 20ml Prilocaine 1% and 8ml Loproimium (iodine-concentration 300mg/ml) was injected. The direction of the injection was defined as cranial, mediad and caudal behind the sternocleidomastoid muscle in a depth of 1-1.5cm. Subsequently, after 30 minutes, a CT-scan of the head and neck region and upper thorax was completed to evaluate the distribution of the injectate in the three-dimensional reconstruction.

Results: The spread of the injectate ranged from the top edge of cervical vertebral body 1 to the bottom edge of thoracic vertebral body 3. The reproduced volume of 75260(5407)mm³ (SD) possessed a maximal cranio-caudal spread of 125(24)mm in the sagittal plane 81(13)mm and in the coronal plane 43(13)mm. The minimal distance to the skin was 0.9(1.0)mm. The patients judged the block to be sufficient under our protocol. Therefore, no patient required conversion to general anesthesia.

Conclusion: Intermediate cervical plexus block is associated with an extensive spread of injectate that transverses the deep cervical fascia. The distribution pattern and the sensory and motor blockade level of this intermediate cervical plexus block seems to be sufficient for surgery and is of minor risk compared to the deep cervical plexus block.

Keywords: Carotid endarterectomy; Cervical plexus block; Spread of local anesthetic; Three-dimensional reconstruction

Abbreviations: CEA: Carotid Endarterectomy; CT: Computed Tomography; SD: Standard Deviation

Introduction

Possible perioperative complications of carotid surgery are myocardial or cerebrovascular infarctions. Different anesthetic procedures are performed for carotid endarterectomy (CEA) [1]. A multicenter, randomized controlled trial did not find any difference in outcome between general and regional anesthesia [2]. There are advantages and disadvantages for both kinds of anesthesia. Patients under general anesthesia have safe control of airways, no pain or anxiety during the operation, and anesthetic agents may offer a degree of neuroprotection [3]. On the other hand, patient population undergoing CEA possesses numerous comorbidities with a high incidence of severe coronary disease and intraoperative propensity for arterial hypotension [2,4]. Shunts should protect the brain from stroke during low cerebral blood flow in the carotid cross-clamping phase, but they damage the arterial wall which might result in cerebral embolism. Intraoperative neurological monitoring under general anesthesia, such as stump pressure measurement (blood pressure measured in the internal carotid artery), EEG or somatosensory evoked potentials, reveal poor sensitivity and specificity regarding the requirement for shunt placement compared to the awake patient [5,6]. Therefore, regional anesthesia has become the favored anesthesia technique for CEA in the last years as it allows direct neurological monitoring [7] and provides effective pain relief with a higher patient satisfaction postoperatively [8].

Carotid surgery requires blockade of the cervical nerves C2-4. This may be performed by using an intermediate cervical plexus block, a deep cervical plexus block or a combination of both [9]. The deep block is technically difficult, needs one to three injections, results more frequently in conversion to general anesthesia and is associated with potentially serious complications, such as injection of the local anesthetic epidurally, subarachnoidly or into the vertebral artery [9]. In contrast, the intermediate block is technically easier and can be performed more rapidly. Clinical trials found, that the intermediate block is equally effective [7,10] or even superior [9] compared to the deep block. Additionally, anatomical studies with dye injections proved that the deep cervical fascia is a penetrable barrier [11,12].

The purpose of this case series was to show the spread of injected local anesthetic after intermediate cervical plexus blockade in a three-dimensional CT-scan. We examined in vivo whether the deep cervical fascia was traversed by the local anesthetic. According to our...
| Patient   | Age (y) | BMI (kg/m²) | Minimal distance of the contrast agent to the skin (mm) | Cranio-caudal spread in relation to the spine | Cranio-caudal spread (mm) | Volume (mm³) | Maximal contrast spread in the sagittal plane (mm) | Maximal contrast spread in the coronal plane (mm) |
|-----------|---------|-------------|-----------------------------------------------------------|-----------------------------------------------|--------------------------|-------------|------------------------------------------------|--------------------------------------------------|
| 1 / m     | 79      | 25          | 1                                                         | middle of CVB3 - lower edge of TVB3           | 102                      | 70236       | 77                                                          | 33                                                        |
| 2 / m     | 70      | 22          | 1                                                         | middle of CVB2 - upper edge of TVB3           | 148                      | 82560       | 79                                                          | 25                                                        |
| 3 / m     | 77      | 29          | 2                                                         | upper edge of CVB2 - lower edge of TVB1      | 101                      | 73038       | 54                                                          | 33                                                        |
| 4 / m     | 73      | 29          | 0                                                         | lower edge of CVB3 - lower edge of TVB3      | 124                      | 86759       | 84                                                          | 36                                                        |
| 5 / m     | 73      | 29          | 1                                                         | lower edge of CVB2 - middle of TVB2          | 133                      | 79701       | 74                                                          | 36                                                        |
| 6 / m     | 76      | 24          | 3                                                         | upper edge of CVB4 - lower edge of TVB3      | 135                      | 66009       | 94                                                          | 50                                                        |
| 7 / f     | 72      | 30          | 0                                                         | middle of CVB2 - lower edge of TVB2          | 128                      | 70518       | 89                                                          | 74                                                        |
| 8 / m     | 83      | 21          | 2                                                         | middle of CVB2 - middle of TVB4              | 169                      | 74025       | 86                                                          | 56                                                        |
| 9 / f     | 74      | 21          | 0                                                         | lower edge of CVB3 - lower edge of TVB2      | 86                       | 77219       | 102                                                        | 35                                                        |
| 10 / m    | 78      | 26          | 0                                                         | lower edge of CVB1 - lower edge of TVB3      | 157                      | 72248       | 79                                                          | 44                                                        |
| 11 / m    | 74      | 29          | 2                                                         | upper edge of CVB1 - upper edge of TVB1      | 138                      | 75045       | 68                                                          | 37                                                        |
| 12 / m    | 67      | 31          | 0                                                         | middle of CVB2 - middle of TVB1              | 108                      | 74438       | 72                                                          | 41                                                        |
| 13 / f    | 61      | 18          | 0                                                         | lower edge of CVB1 - lower edge of TVB2      | 123                      | 79202       | 70                                                          | 40                                                        |
| 14 / m    | 78      | 29          | 0                                                         | lower edge of CVB3 - upper edge of TVB1      | 103                      | 72069       | 103                                                         | 57                                                        |
| mean (SD) | 74 (5)  | 26 (4)      | 0.9 (1.0)                                                |                                                | 125 (24)                 | 75260 (5407) | 81 (13)                                               | 43 (13)                                                 |

BMI = body mass index; CVB = cervical vertebral body; f = female; m = male; TVB = thoracic vertebral body

Table 1: Demographic data of the 14 patients with radiological contrast agent spread.

knowledge, such a deep cervical fascia penetrability of local anesthetic in vivo has not yet been described.

Materials and Methods

After approval by the institutional ethics committee (Kantonale Ethik-Kommission des Kantons Luzern, protocol number 708) and written informed consent, 14 consecutive American Society of Anesthesiologists class II-III patients undergoing elective CAE were enrolled into this study (74±5yr of age and 26±4kg/m² body mass index). Exclusion criteria included known bleeding disorder, history of allergy to local anesthetics or to iodized X-ray contrast mediums, local sepsis, acute cardiac-decompensation, severe respiratory insufficiency or known diaphragmatic motion abnormalities.

After routine monitoring of five-lead electrocardiography, noninvasive blood pressure, pulse oxymetry and peripheral insertion of a 18G intravenous cannula, a 20G cannula was placed in the contralateral radial artery for continuous blood pressure monitoring. 2L/min oxygen was administered nasally. Regional anesthesia was performed by two senior anesthesiologists with patients in supine position and the head turned slightly away from the side of surgery. After skin disinfection, an atrumatic needle for peripheral nerve blocks (Stimuplex D 25Gx35mm, B. Braun, Melsungen, Germany) was inserted on the level between injectate and skin, whereat in 7 patients (50%) the injectate adjoined the skin. In one out of the total of 14 patients there was a local anesthetic sheathing of the carotis artery or not (Table 1).

Statistical analysis was done using the commercially available software package MS-Excel XP 2003 (Microsoft Corporation, Redmond, WA 98052 USA). Data are depicted as mean and standard deviation (SD).

Results

The medial cranio-caudal spread of the contrast medium was averaged 125 (24)mm with a maximal cranial spread to the top edge of cervical vertebral body 1 and a maximal caudal spread to the bottom edge of thoracic vertebral body 3. In the sagittal plane there was a medium distribution of averaged 81 (13)mm and in the coronal plane of averaged 43 (13)mm. The average distribution volume in the scanographic sequential cross section was 75’260 (5407)mm³ (Figure 1 and 2). In the sample, we measured a medium distance of 0.9 (1.0)mm between injectate and skin, whereat in 7 patients (50%) the injectate adjoined the skin. In one out of the total of 14 patients there was a local anesthetic sheathing of the carotis artery over a distance of 34mm. No patient required conversion to general anesthesia.
Discussion

In the current case series, we demonstrated the spread of injected local anesthetic after standardized intermediate cervical plexus blockade using a three-dimensional CT-scan reconstruction of the injectate. Thereby, we confirmed the anatomical studies visually in vivo which showed by the use of dye injection that the deep cervical fascia is a penetrable barrier for local anesthetics [11,12].

The cervical block can either be superficial or below the deep cervical fascia. The superficial block should be termed “intermediate” in an anatomically correct manner because the needle pierces the investing fascia of the neck [9,13]. As mentioned above, the deep block technique is more difficult to perform, is more likely to evoke serious complications but is not more successful compared to the intermediate block, and intraoperatively, surgeons were unable to distinguish the type of block used [7,9,10,14,15]. A further advantage of the intermediate block is its rapid performance. After skin disinfection, we accomplished one skin puncture without sterile medical drape, ultrasound use or nerve-stimulation. In the literature, we found different volumes of local anaesthetic injection from three different angles (A: anterior, B: right oblique anterior, C: left lateral/posterior oblique). Contrast media distribution is pointed out by white arrows. Additional central subclavian line on the right side.

Figure 1: Axial native CT images of the left sided contrast media/anaesthetic injection at three different levels of the neck (A: submandibular, B: mid neck laryngeal level, C: superior thorax aperture). No ring like union of the contrast media around the carotid artery was achieved in this case. Contrast media extents down to the left sternal-clavicular joint.

Figure 2: Three-dimensional images of the left sided contrast media/anaesthetic injection from three different angles (A: anterior, B: right oblique anterior, C: left lateral/posterior oblique). Contrast media distribution is pointed out by white arrows. Additional central subclavian line on the right side.

In conclusion, we showed in vivo the permeability of the deep cervical fascia for local anesthetics after intermediate cervical plexus blockade. The intermediate cervical plexus blockade can be performed rapidly, is sufficient for surgery according to our protocol and provides an alternative approach to the deep cervical block for CEA with a lower rate of complications.

Conflict of Interest: There are no conflicts of interests.

References
1. Howell SJ (2007) Carotid endarterectomy. Br J Anaesth 99:119-131.
2. Lewis SC, Warlow CP, Bodenham AR, Colam B, Rothwell PM, et al. (2008) General anaesthesia versus local anaesthesia for carotid surgery (GALA); a multicentre, randomised controlled trial. Lancet 372: 2132-2142.
3. Payne RS, Akca O, Roewer N, Schurr A, Kehl F (2005) Sevoflurane-induced preconditioning protects against cerebral ischemic neuronal damage in rats. Brain Res 1034: 147-152.
4. McCleary AJ, Marltati G, Gough MJ (2001) Carotid endarterectomy; local or general anaesthesia? Eur J Vasc Endovasc Surg 22: 1-12.
5. Hans SS, Jareenpoon O (2007) Prospective evaluation of electrophysiological, carotid artery stump pressure, and neurologic changes during 314 consecutive carotid endarterectomies performed in awake patients. J Vasc Surg 45: 511-515.
6. Schneemilch CE, Ludwig S, Ulrich A, Halloul Z, Hachenberg T (2007) [Somatosensory evoked potentials and biochemical markers of neuronal deficits in patients undergoing carotid endarterectomy under regional anaesthesia]. Zentralbl Chir 132: 176-182.
7. Halk M, Micheal P, Sevick P, Pavlkova J, Stern M (2007) Regional anaesthesia for carotid endarterectomy: an audit over 10 years. Br J Anaesth 99: 415-420.
8. Messner M, Albrecht S, Lang W, Stitt R, Dinkel M (2007) The superficial cervical plexus block for postoperative pain therapy in carotid artery surgery. A prospective randomised controlled trial. Eur J Vasc Endovasc Surg 33: 50-54.
9. Pandit JJ, Satya-Krishna R, Gratton P (2007) Supraclavicular or deep cervical plexus block for carotid endarterectomy: a systematic review of complications. Br J Anaesth 99: 159-169.
10. Pandit JJ, Breu S, Dillon P, Elocak D, McLaren ID, et al. (2000) A comparison of superficial versus combined (superficial and deep) cervical plexus block for carotid endarterectomy: a prospective, randomized study. Anaesth Analg 91: 781-786.
11. Nash L, Nicholson HD, Zhang M (2005) Does the investing layer of the deep cervical fascia exist? Anesthesiology 103: 962-968.
12. Pandit JJ, Dutta D, Morris JF (2003) Spread of injectate with superficial cervical plexus block in humans: an anatomical study. Br J Anaesth 91:733-735.
13. Telford RJ, Stoneham MD (2004) Correct nomenclature of superficial cervical plexus blocks. Br J Anaesth 92: 775-776.

14. Stoneham MD, Doyle AR, Knighton JD, Dorje P, Stanley JC (1998) Prospective, randomized comparison of deep or superficial cervical plexus block for carotid endarterectomy surgery. Anesthesiology 89: 907-912.

15. Barone M, Diemunsch P, Baldassarre E, Oben WE, Ciarlo M, et al. (2010) Carotid endarterectomy with intermediate cervical plexus block. Tex Heart Inst J 37: 297-300.

16. Winnie AP, Ramamurthy S, Durrani Z, Radonjic R (1975) Interscalene cervical plexus block: a single-injection technic. Anesth Analg 54: 370-375.

17. Kefalianakis F, Koeppel T, Geldner G, Gahlen J (2005) [Carotid-surgery in ultrasound-guided anesthesia of the regio colli lateralis]. Anesthesiol Intensivmed Notfallmed Schmerzther 40: 576-581.

18. Tissot S, Frering B, Gagnieu MC, Vallon JJ, Motin J (1997) Plasma concentrations of lidocaine and bupivacaine after cervical plexus block for carotid surgery. Anesth Analg 84: 1377-1379.

19. Dhonneur G, Saidi NE, Merle JC, Asfazadourian H, Ndoko SK, et al. (2007) Demonstration of the spread of injectate with deep cervical plexus block: a case series. Reg Anesth Pain Med 32: 116-119.

20. Davies MJ, Silbert BS, Scott DA, Cook RJ, Mooney PH, et al. (1997) Superficial and deep cervical plexus block for carotid artery surgery: a prospective study of 1000 blocks. Reg Anesth 22: 442-446.

21. Pintaric TS, Hocevar M, Jereb S, Casati A, Jankovic VN (2007) A prospective, randomized comparison between combined (deep and superficial) and superficial cervical plexus block with levobupivacaine for minimally invasive parathyroidectomy. Anesth Analg 105: 1160-1163.