

The Superficial Cervical Plexus Block for Postoperative Pain Therapy in Carotid Artery Surgery. A Prospective Randomised Controlled Trial

M. Messner,^{1,a*} S. Albrecht,^{1,a} W. Lang,² R. Sittl¹ and M. Dinkel³

¹Department of Anesthesiology, Friedrich-Alexander Universität, Erlangen, Germany, ²Department of Surgery, Division of Vascular and Endovascular Surgery, Friedrich-Alexander Universität, Erlangen, Germany, and ³Department of Anesthesiology, Herz-und Gefäß-Klinik, Bad Neustadt, Germany

Objectives. Rapid and reliable neurological evaluation soon after carotid artery surgery is feasible with modern methods of general anesthesia, but postoperative pain therapy remains a challenge. Use of opioids can mask neurological deficits. We investigated whether superficial cervical plexus block reduced postoperative opioid consumption after carotid endarterectomy.

Design. Prospective, randomised, double-blinded, placebo controlled trial.

Methods. 46 patients undergoing unilateral carotid endarterectomy under general anesthesia were randomized to either superficial cervical block with ropivacaine (n = 23) or placebo (n = 23). A patient controlled analgesia device (PCA) delivering morphine was provided for all patients. Subjective pain levels (visual analog scale, VAS) were recorded. The primary outcome was total morphine consumption on discharge from the recovery room. Secondary outcomes included arterial pCO₂ (as an indicator of central nervous effects of morphine) and patient satisfaction.

Results. No adverse effects of the superficial cervical plexus block were reported. Four patients in the placebo group were excluded because of other drug use post-operatively. Per protocol analysis compared 23 patients in ropivacaine group and 19 patients in the placebo group. The ropivacaine group had a significant reduction in morphine consumption (3.8 ± 2.0 versus 12.9 ± 4.0 , $p < 0.001$), lower maximal pain scores (2.6 ± 2.0 versus 5.8 ± 1.6 , $p < 0.001$), and paco₂ levels (39.0 ± 2.6 versus 41.9 ± 3.4 , $p = 0.008$) at discharge from the recovery room. Patient satisfaction (1 = very good to 6 = insufficient) was substantially higher in the ropivacaine group (1.7 ± 0.7 versus 3.1 ± 1.2 , $p < 0.01$).

Conclusion. The significant and clinically relevant lower morphine consumption and pain score, as well as the substantially higher patient satisfaction demonstrate that superficial cervical plexus block provides effective pain relief for patients undergoing carotid endarterectomy.

Keywords: Carotid artery surgery; pain therapy; superficial cervical plexus block.

Introduction

Reducing perioperative stress is critical to minimizing cardiovascular complications, especially in patients undergoing carotid surgery. Sufficient postoperative pain therapy therefore is very important to achieving a low complication rate. Performing the procedure under general anaesthesia with modern short acting anaesthetics provides good intraoperative hemodynamic stability, good operating conditions and rapid recovery for immediate and reliable neurological evaluation, but underlines the importance of

postoperative pain therapy. To achieve effective pain relief a combination of general anaesthesia and regional analgesic technique seems desirable. The aim of this study was to test the hypothesis that superficial cervical plexus block, with ropivacaine, would reduce postoperative morphine consumption in patients undergoing unilateral carotid endarterectomy under general anaesthesia.

Material and Methods

Consecutive patients scheduled for elective, unilateral, carotid artery surgery were recruited over a time period of 6 months. Patients with chronic pain and/or analgesic therapy before surgery, patients not capable of using the visual analog scale (VAS scale), and

*Corresponding author. Dr. M. Messner, Universitätsklinikum Erlangen, Krankenhausstr. 12, 91054 Erlangen, Germany.

E-mail address: messner@gmx.li

^a These two authors have contributed equally to this work.

patients with known allergic reactions to the study medication were excluded. The trial was approved by the local ethical committee and all patients provided informed consent. A flow diagram of patients through the trial is depicted in Fig. 1.

The procedure was performed with a standardised general anesthetic regimen. Patients received 10 to 20 mg chlorazepate the evening before surgery, and 3.75 mg midazolam in the morning. Oral antihypertensive therapy was continued until surgery. Anesthesia was induced with remifentanyl, etomidate, rocuronium and after tracheal intubation maintained with sevoflurane 0.5–1.5% and remifentanyl 0.1–0.25 µg/kg/min. Patients were randomly assigned to the ropivacaine or placebo group, using a previously generated, continuous randomization list, kept in a closed envelope by the first author. Before induction of anesthesia the envelope was handed to an anesthesia nurse not involved in the study and in the further

treatment of the patient. She was asked to prepare identical syringes either containing 10 ml Ropivacaine 10 mg/ml or 10 ml NaCl 0.9% solution according to the randomisation number on the list. After induction of anesthesia the superficial cervical plexus block was performed. All persons involved in the anesthetic and surgical management were blinded to the actual medication (i.e. anesthesiologist, surgeon and recovery room nurses). A 22G needle was inserted at the posterior border of the sternocleidomastoid muscle at the level of C4. Ropivacaine or identical saline placebo was injected in cranial, caudal and dorsal direction. During the procedure SSEP (somatosensory evoked potentials) monitoring (Viking IV, Nicolet Biomedical Inc. Madison, Wisconsin) of the median nerve was performed to detect carotid clamp associated cerebral ischaemia and any need for shunt insertion.

After admission to the recovery room a patient controlled analgesia was provided (Graseby PCA 3300,

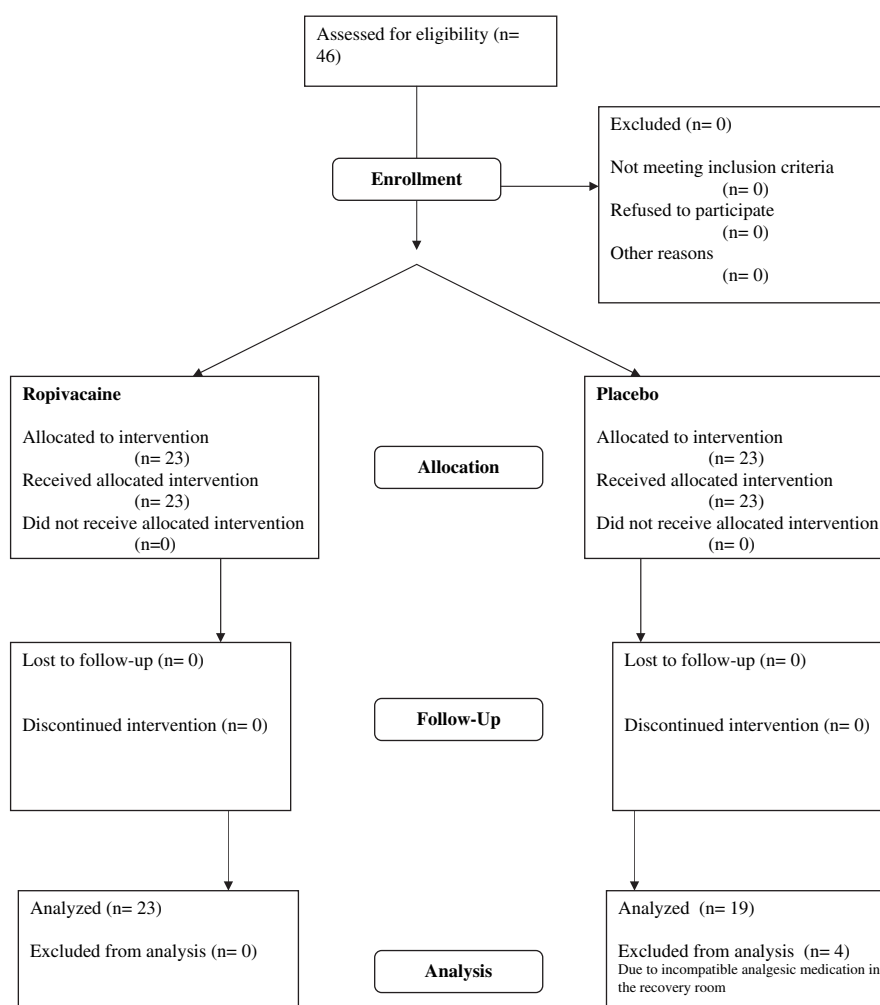


Fig. 1. Flow diagram of patients throughout the trial.

Smiths Medical International Ltd, UK) allowing the patients an i.v. dosage of 1 mg Morphine without continuous rate and a five minute lock out time. Additional Morphine could be administered, if necessary. No other analgesic drugs were used. Pain levels were assessed every 15 minutes using a standard, continuous, horizontal, visual analogue scale. Patients were asked to rate their pain on a VAS consisting of a 10-cm line with the anchor points, "no pain" and "worst possible pain" shown in Fig. 2.¹ At discharge from the recovery room arterial pCO₂ was documented and the patients asked to score the quality of pain therapy between 1 (very good) and 6 (insufficient).

Power calculations showed that the minimum sample size required for demonstrating a 5 mg reduction in morphine consumption was 26 patients, 13 patients in each group (one sided test, $\alpha < 0.05$, $1 - \beta > 0.8$, $\delta = 5$ mg, $\sigma = 5$). Per protocol analysis of the differences between the groups in morphine consumption, maximum pain level, pCO₂ level and quality of pain therapy were performed using Mann Whitney U Test (SPSS, SPSS Inc. Chicago, USA). Values are given as mean and standard deviation.

Results

The mean age of patients was 69 years (range 47 to 88 years), including 10 women (24%) and 36 men (76%). Thirty-five Patients (83%) suffered from arterial hypertension and had oral antihypertensive therapy. Diabetes mellitus was diagnosed in 9 patients (21%). Sixteen patients had coronary artery disease (38%), 3 of them had a history of myocardial infarction and 9 of cardiac surgery. Carotid artery disease was asymptomatic in 24 patients, the other 22 had ipsilateral hemispheric symptoms (transient $n = 12$; stroke $n = 10$). The two randomized groups were well matched for baseline factors (Table 1). Four patients of the control group had to be excluded due to concurrent use of non-steroidal anti-inflammatory drugs (NSAIDs) in the recovery room. Twenty three patients of the ropivacaine group and 19 patients of the placebo group could be evaluated. Surgical technique was endarterectomy with patch closure in 36 cases (ropivacaine group $n = 19$, placebo group $n = 17$), eversion endarterectomy in 5 cases (ropivacaine group $n = 3$, placebo group $n = 2$) and graft interposition in 1 case

No pain |-----| Worst possible pain

Fig. 2. VAS consisting of a 10-cm line with the anchor points, "no pain" and "worst possible pain".¹

Table 1. Differences of age, sex, prevalence of risk factors for arteriosclerosis and clinical status of carotid disease between the groups

	Ropivacaine Group ($n = 23$)	Placebo Group ($n = 23$)	
Age (mean \pm SD)	69 \pm 6	70 \pm 8	$p = 0.732^a$
Number of females (n)	5	5	$p = 1.000^b$
Hypertension (n)	19	16	$p = 0.318^b$
Diabetes mellitus (n)	5	4	$p = 1.000^b$
Coronary artery disease (n)	8	8	$p = 1.000^b$
Asymptomatic patients (n)	11	13	$p = 0.773^b$
Patients with TIA (n)	6	6	$p = 1.000^b$
Patients with stroke (n)	5	5	$p = 1.000^b$

^a U-Test.

^b Two tailed Fisher's Exact Test.

(ropivacaine group). No shunts were used. No new neurological deficits were observed within 24 hours after surgery. One patient in the ropivacaine group suffered a non-fatal myocardial infarction the day after surgery. Complications due to the superficial cervical plexus block, like hematoma, infection, lesion of a neural structure intravascular or intrathecal injection, impaired diaphragmatic function or allergic reaction did not occur.

Patients were observed in the recovery room for 123 ± 45 minutes. Total morphine consumption was 3.8 ± 2.0 mg in the ropivacaine group and 12.9 ± 4.0 in the placebo group ($p < 0.001$). In four patients of the placebo group additional morphine (1–5 mg) had to be administered. Maximum VAS score was 2.6 ± 2.0 in the ropivacaine group versus 5.8 ± 1.6 in the placebo group ($p < 0.001$). Maximum VAS levels were documented 52 ± 29 minutes after admission to the recovery room in the ropivacaine group, respectively 26 ± 17 minutes in the placebo group. Arterial pCO₂ levels at discharge from the recovery room were 39.0 ± 2.6 in the ropivacaine and 41.9 ± 3.4 in the placebo group ($p = 0.008$). Patients in the ropivacaine group rated the quality of pain therapy 1.7 ± 0.7 compared to 3.1 ± 1.2 in the placebo group ($p < 0.01$). The results are summarized in Table 2.

Discussion

In this randomized trial, we have demonstrated that superficial cervical plexus block with ropivacaine reduced more than 3-fold opioid consumption in the recovery room. The high patient controlled morphine demand in the placebo group stresses the need of an appropriate pain therapy regimen for carotid surgery patients. The impact on close surveillance, requiring

Table 2. Maximum VAS score, total morphine consumption, arterial pCO₂ levels and patients rating of the quality of pain therapy at discharge from the recovery room

	Ropivacaine Group (n = 23)	Placebo Group (n = 19)	
Maximum VAS score	2.6 ± 2.0	5.8 ± 1.6	p < 0.001
Morphine consumption (mg)	3.8 ± 2.0	12.9 ± 4.0	p < 0.001
Arterial pCO ₂ (mmHg)	39.0 ± 2.6	41.9 ± 3.4	p = 0.008
Patient Satisfaction (1–6)	1.7 ± 0.7	3.1 ± 1.2	p < 0.001

neuropsychological testing, could not be demonstrated in this study design, but the difference in pCO₂ levels at discharge from the recovery room reflected central nervous effects and clinical relevance of opioid administration. Additional use of NSAIDs, which were explicitly excluded in this study, would most likely further reduce opioid administration and increase the proportion of patients who will not require opioids at all. There were no patients in the ropivacaine group in which morphine requirements or pain scores suggested that a satisfactory block had not been achieved. This stresses the reliability of this technique.

Indications for carotid endarterectomy have been established by large randomised clinical studies.^{2–7} The benefits of surgery must outweigh the perioperative risk.^{8–11} Achieving a low perioperative complication rate is challenging, given the major comorbidities of these patients. The perioperative management for carotid endarterectomy has to be refined by surgeons and anesthesiologists. In this context advantages of general versus regional anesthesia are being discussed.^{12–18} So far there is no clear evidence for the superiority of any single technique.¹⁹ The still ongoing GALA trial might provide additional information on this topic. However, the peri-operative complication rate of each unit remains a relevant endpoint, however this is achieved.

Combining general and regional anesthesia for postoperative pain therapy is well established in paediatric anesthesia and major abdominal or thoracic surgery, whenever the benefit outweighs the additional risk. Superficial cervical plexus block, for carotid surgery, is an easy technique for blocking cutaneous branches of the cervical plexus (great auricular nerve, transverse cervical nerve, supraclavicular nerve and lesser occipital nerve) at Erb's point (punctum nervosum), which is located on the posterior border of the sternocleidomastoid muscle midway between its attachments to the mastoid process, and the sternum and clavicle. Carotid surgery may be performed during superficial cervical plexus block alone providing operating conditions comparable to deep cervical

plexus block or combined deep and superficial block.^{20–22} Both techniques need additional local infiltration by the surgeon. The equal efficacy of superficial and deep/combined block may be explained by the fact, that after an injection of dye for superficial block – under the investing fascia of a cadaver – dye can be found in the deep cervical space coating cervical nerve roots,²³ obviously because of the discontinuity of the investing layer of the deep cervical fascia.^{24,25} This is not the case after a subcutaneous injection. Therefore the term intermediate cervical plexus block was suggested but is not in widespread use.²⁶ Compared to local wound infiltration superficial cervical plexus block offers better analgesia, is simple to perform and bears no additional risk. Bilateral superficial cervical plexus block has been successfully used for postoperative pain therapy after thyroid surgery under general anesthesia.²⁷ This combination has not been reported previously for carotid surgery.

This trial showed that superficial cervical plexus block was safe, easy to perform and an effective procedure to reduce morphine consumption and improve pain relief after carotid endarterectomy under general anesthesia.

References

- CARLSSON AM. Assessment of chronic pain. I. Aspects of the reliability and validity of the visual analogue scale. *Pain* 1983;16: 87–101.
- Randomised trial of endarterectomy for recently symptomatic carotid stenosis: Final results of the mrc european carotid surgery trial (ecst). *Lancet* 1998;351:1379–1387.
- FERGUSON GG, ELIASZIW M, BARR HW, CLAGETT GP, BARNES RW, WALLACE MC *et al.* The north american symptomatic carotid endarterectomy trial: Surgical results in 1415 patients. *Stroke* 1999;30: 1751–1758.
- ROTHWELL PM, ELIASZIW M, GUTNIKOV SA, FOX AJ, TAYLOR DW, MAYBERG MR *et al.* Analysis of pooled data from the randomised controlled trials of endarterectomy for symptomatic carotid stenosis. *Lancet* 2003;361:107–116.
- Endarterectomy for asymptomatic carotid artery stenosis. Executive committee for the asymptomatic carotid atherosclerosis study. *Jama* 1995;273:1421–1428.
- HALLIDAY A, MANSFIELD A, MARRO J, PETO C, PETO R, POTTER J *et al.* Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: Randomised controlled trial. *Lancet* 2004;363: 1491–1502.
- ROTHWELL PM, GOLDSTEIN LB. Carotid endarterectomy for asymptomatic carotid stenosis: Asymptomatic carotid surgery trial. *Stroke* 2004;35:2425–2427.
- MOORE WS, BARNETT HJ, BEEBE HG, BERNSTEIN EF, BRENER BJ, BROTT T *et al.* Guidelines for carotid endarterectomy. A multidisciplinary consensus statement from the ad hoc committee, american heart association. *Stroke* 1995;26:188–201.
- BILLER J, FEINBERG WM, CASTALDO JE, WHITTEMORE AD, HARBAUGH RE, DEMPSEY RJ *et al.* Guidelines for carotid endarterectomy: A statement for healthcare professionals from a special writing group of the stroke council, american heart association. *Stroke* 1998;29:554–562.

- 10 BOND R, RERKASEM K, ROTHWELL PM. Systematic review of the risks of carotid endarterectomy in relation to the clinical indication for and timing of surgery. *Stroke* 2003;**34**:2290–2301.
- 11 SACCO RL, ADAMS R, ALBERS G, ALBERTS MJ, BENAVENTE O, FURIE K *et al.* Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: A statement for health-care professionals from the american heart association/american stroke association council on stroke: Co-sponsored by the council on cardiovascular radiology and intervention: The american academy of neurology affirms the value of this guideline. *Stroke* 2006;**37**:577–617.
- 12 ASSADIAN A, SENEKOWITSCH C, ASSADIAN O, PTAKOVSKY H, HAGMULLER GW. Perioperative morbidity and mortality of carotid artery surgery under loco-regional anaesthesia. *Vasa* 2005;**34**:41–45.
- 13 WATTS K, LIN PH, BUSH RL, AWAD S, MCCOY SA, FELKAI D *et al.* The impact of anesthetic modality on the outcome of carotid endarterectomy. *Am J Surg* 2004;**188**:741–747.
- 14 STONEHAM MD, KNIGHTON JD. Regional anaesthesia for carotid endarterectomy. *Br J Anaesth* 1999;**82**:910–919.
- 15 LEONI A, MAGRIN S, MASCOTTO G, RIGAMONTI A, GALLIOLI G, MUZZOLON F *et al.* Cervical plexus anesthesia for carotid endarterectomy: Comparison of ropivacaine and mepivacaine. *Can J Anaesth* 2000;**47**:185–187.
- 16 KNIGHTON JD, STONEHAM MD. Carotid endarterectomy. A survey of uk anaesthetic practice. *Anaesthesia* 2000;**55**:481–485.
- 17 CARLING A, SIMMONDS M. Complications from regional anaesthesia for carotid endarterectomy. *Br J Anaesth* 2000;**84**:797–800.
- 18 TANGKANAKUL C, COUNSELL CE, WARLOW CP. Local versus general anaesthesia in carotid endarterectomy: A systematic review of the evidence. *Eur J Vasc Endovasc Surg* 1997;**13**:491–499.
- 19 RERKASEM K, BOND R, ROTHWELL PM. Local versus general anaesthesia for carotid endarterectomy. *Cochrane Database Syst Rev* 2004:CD000126.
- 20 STONEHAM MD, DOYLE AR, KNIGHTON JD, DORJE P, STANLEY JC. Prospective, randomized comparison of deep or superficial cervical plexus block for carotid endarterectomy surgery. *Anesthesiology* 1998;**89**:907–912.
- 21 PANDIT JJ, BREE S, DILLON P, ELCOCK D, MCLAREN ID, CRIDER B. A comparison of superficial versus combined (superficial and deep) cervical plexus block for carotid endarterectomy: A prospective, randomized study. *Anesth Analg* 2000;**91**:781–786.
- 22 DE SOUSA AA, FILHO MA, FAGLIONE Jr W, CARVALHO GT. Superficial vs combined cervical plexus block for carotid endarterectomy: A prospective, randomized study. *Surg Neurol* 2005;**63**(Suppl. 1):S22–S25.
- 23 PANDIT JJ, DUTTA D, MORRIS JF. Spread of injectate with superficial cervical plexus block in humans: An anatomical study. *Br J Anaesth* 2003;**91**:733–735.
- 24 ZHANG M, LEE AS. The investing layer of the deep cervical fascia does not exist between the sternocleidomastoid and trapezius muscles. *Otolaryngol Head Neck Surg* 2002;**127**:452–454.
- 25 NASH L, NICHOLSON HD, ZHANG M. Does the investing layer of the deep cervical fascia exist? *Anesthesiology* 2005;**103**:962–968.
- 26 TELFORD RJ, STONEHAM MD. Correct nomenclature of superficial cervical plexus blocks. *Br J Anaesth* 2004;**92**:775 [author reply 775–776].
- 27 DIEUDONNE N, GOMOLA A, BONNICHON P, OZIER YM. Prevention of postoperative pain after thyroid surgery: A double-blind randomized study of bilateral superficial cervical plexus blocks. *Anesth Analg* 2001;**92**:1538–1542.

Accepted 13 June 2006

Available online 8 September 2006