Meta-analysis of retrojugular versus antejugular approach for carotid endarterectomy

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ABSTRACT

INTRODUCTION The retrojugular approach for carotid endarterectomy (CEA) has been reported to have the advantages of shorter operative time and ease of dissection, especially in high carotid lesions. Controversial opinion exists with regard to its safety and benefits over the conventional antejugular approach.

METHODS A systematic review of electronic information sources was conducted to identify studies comparing outcomes of CEA performed with the retrojugular and antejugular approach. Synthesis of summary statistics was undertaken and fixed or random effects models were applied to combine outcome data.

FINDINGS A total of 6 studies reporting on a total of 740 CEAs (retrojugular approach: 333 patients; antejugular approach: 407 patients) entered our meta-analysis models. The retrojugular approach was found to be associated with a higher incidence of laryngeal nerve damage (odds ratio [OR]: 3.21, 95% confidence interval [CI]: 1.46–7.07). No significant differences in the incidence of hypoglossal or accessory nerve damage were identified between the retrojugular and antejugular approach groups (OR: 1.09 and 11.51, 95% CI: 0.31–3.80 and 0.59–225.43). Cranial nerve damage persisting during the follow-up period was similar between the groups (OR: 2.96, 95% CI: 0.79–11.13). Perioperative stroke and mortality rates did not differ in patients treated with the retrojugular or antejugular approach (OR: 1.26 and 1.28, 95% CI: 0.31–5.21 and 0.25–6.50).

CONCLUSIONS Currently, there is no conclusive evidence to favour one approach over the other. Proof from a well designed randomised trial would help determine the role and benefits of the retrojugular approach in CEA.

KEYWORDS

Carotid endarterectomy – Retrojugular approach – Nerve damage – Hypoglossal nerve – Laryngeal nerve – Systematic review – Metaanalysis

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Conventional exposure of the anatomical structures in carotid surgery is through a dissection plane anterior and medial to the internal jugular vein. The standard antejugular approach to the carotid bifurcation used in carotid endarterectomy (CEA) involves division of the facial vein and the other anterior tributaries of the internal jugular vein, allowing it to be retracted laterally as well as mobilisation of the ansa cervicalis and dissection of the hypoglossal nerve. The retrojugular approach is an alternative technique that was used originally to provide an easier and safer dissection plane through unscarred tissue in 'redo' surgery or to allow better exposure in high carotid lesions.¹

In recent years, there has been a resurgence of interest in the retrojugular approach as an alternative approach to CEA.^{1,2} Proponents of this technique assert it to be safe and afford higher exposure of the internal carotid artery, especially in high bifurcations. Furthermore, absence of posterior branches of the internal jugular vein and decreased

need for mobilisation of the hypoglossal nerve may create shorter operating times.^{3,4} Concerns, however, have been postulated with regard to the high incidence of cranial nerve injury resulting from a different dissection area, especially damage to the accessory nerve and branches of the vagus nerve.^{5–8} The objective of the present study was to conduct a systematic review of the literature and perform a meta-analysis of the outcomes of CEA using the antejugular and retrojugular approach.

Methods

Studies comparing outcomes of CEA performed using the retrojugular approach with those of CEA using the antejugular approach were selected. Studies including patients with symptomatic or asymptomatic carotid disease treated with the conventional (primary or patch closure) or eversion CEA technique under regional or general anaesthesia were considered.

Search strategy

Electronic bibliographic sources (MEDLINE®) were searched using a web-based search engine (PubMed). A supplementary manual search of the reference lists of relevant articles was performed. The keywords used to identify eligible articles were “carotid endarterectomy” AND “retrojugular” OR “antejugular”.

Data collection

Study selection and data extraction was performed independently by two authors (GAA and SAA). The methodological quality of the studies included in the analysis was appraised using the Jadad or Newcastle–Ottawa scale for randomised trials and observational studies respectively. Prespecified outcome parameters to be analysed included damage of specific cranial nerves (laryngeal, hypoglossal, accessory nerve) and early postoperative adverse cerebrovascular events.

Statistical analysis

Synthesis of summary statistics was undertaken as individual patient data from different studies could not be amalgamated. Statistical analysis of dichotomous variables was performed using the odds ratio (OR) as the summary statistic. Pooled ORs with 95% confidence intervals (CIs) were calculated using the Mantel–Haenszel fixed effects model unless evidence of between-study heterogeneity existed, in which case random effects models of DerSimonian and Laird were applied. Between-study heterogeneity was examined with the combination of Cochran’s Q (χ^2) test and the I² statistic. Publication bias was assessed both visually (by evaluating the symmetry of funnel plots) and formally (using the Egger’s regression intercept).

A *p*-value of <0.05 was chosen as the level of significance. Sensitivity analyses were undertaken on the assumption that the type of study (randomised versus non-randomised clinical studies) might affect the overall outcome estimates. Pooled data analyses and publication bias tests were performed using RevMan 5 (Nordic Cochrane Centre, Copenhagen, Denmark). Egger’s test was performed with Comprehensive Meta-Analysis version 2.0 (Biostat, Englewood, NJ, US).

Results

Our search identified six studies comparing the retrojugular with the antejugular approach for CEA.^{1,4,5,7–9} The analysis included 740 CEAs, 333 of which were performed using the retrojugular approach and 407 with the antejugular approach.

The reports were published between 2002 and 2009. Significant heterogeneity in study design was identified. Two studies were randomised controlled trials (RCTs)^{5,6} and another three studies were retrospective or prospective observational reports.^{1,4,9} A correspondence reporting a brief summary of a single author retrospective experience was included.⁸ The RCTs achieved low methodological quality scores (Jadad scale <3). Two of the observational studies had high methodological quality (Newcastle–Ottawa scale ≥7) and one observational study had a low quality score. The inclusion and exclusion criteria for patient enrolment in the studies are outlined in Table 1. The baseline demographic/clinical and procedural characteristics (conventional/eversion endarterectomy, general/regional anaesthesia, selective/routine shunting) were similar in the retrojugular and antejugular approach groups (Table 2).

Table 1 Study characteristics

Study	Type of study	Study quality (Jadad / NOS)	Patients	RJ group	AJ group	Criteria for inclusion	Criteria for exclusion
Beasley, 2008 ¹	Retrospective	7	236	91	145	NR	NR
Kluk, 2009 ⁴	Retrospective	8	177	80	97	Symptomatic >70% stenosis	NR
Neri, 2003 ⁵	RCT	2	100	50	50	NR	Bleeding diathesis, allergy to local anaesthetic, local sepsis, pulmonary disease, diaphragmatic motion abnormalities
Stehr, 2008 ⁷	RCT	3	101	49	52	Symptomatic >50% or asymptomatic >70% stenosis (DEGUM criteria)	Previous neck operation / radiotherapy
Onwudike, 2006 ⁸	Correspondence	–	40	20	20	NR	NR
Safar, 2002 ⁹	Prospective, non-randomised	5	86	43	43	NR	NR

NOS = Newcastle–Ottawa scale; RJ = retrojugular; AJ = antejugular; NR = not reported; RCT = randomised controlled trial; DEGUM = Deutsche Gesellschaft für Ultraschall in der Medizin

Table 2 Baseline demographic/clinical and procedural characteristics of the study populations

	Beasley, 2008 ¹		Kluk, 2009 ⁴		Neri, 2003 ⁵		Stehr, 2008 ⁶		Onwudike, 2006 ⁸		Safar, 2002 ⁹	
	RJ (n=91)	AJ (n=145)	RJ (n=80)	AJ (n=97)	RJ (n=50)	AJ (n=50)	RJ (n=49)	AJ (n=52)	RJ (n=20)	AJ (n=20)	RJ (n=43)	AJ (n=43)
Mean age	NR	NR	71	71	NR	NR	73	70	NR	NR	73 (SD: 6)	69 (SD: 5)
Male sex	NR	NR	56 (70%)	64 (66%)	NR	NR	31 (63%)	34 (65%)	NR	NR	31 (72%)	29 (67%)
Hypertension	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	25 (58%)	22 (51%)
Diabetes mellitus	NR	NR	NR	NR	NR	NR	14 (29%)	16 (31%)	NR	NR	13 (30%)	15 (35%)
Coronary artery disease	NR	NR	NR	NR	NR	NR	30 (61%)	23 (44%)	NR	NR	27 (63%)	24 (56%)
Asymptomatic stenosis	NR	NR	NR	NR	NR	NR	33 (67%)	33 (63%)	NR	NR	4 (9%)	1 (2%)
Regional anaesthesia	91 (100%)	145 (100%)	36 (45%)	49 (51%)	50 (100%)	50 (100%)	3 (6%)	4 (8%)	NR	NR	20 (47%)	0 (0%)
Shunting	NR	NR	47 (59%)	42 (43%)	6 (12%)	4 (8%)	NR	NR	NR	NR	18 (42%)	43 (100%)
Eversion endarterectomy	91 (100%)	145 (100%)	0 (0%)	0 (0%)	15 (30%)	12 (24%)	49 (100%)	52 (100%)	NR	NR	0 (0%)	0 (0%)

RJ = retrojugular; AJ = antejugular; NR = not reported; SD = standard deviation

Cranial nerve injury

Figure 1 shows forest plots comparing laryngeal nerve damage, hypoglossal nerve damage, accessory nerve damage and persistent nerve damage rates between the retrojugular and antejugular approach groups. Five studies reported rates of laryngeal nerve injury.^{1,4,7-9} In two studies, laryngoscopy was performed routinely to identify damage to the laryngeal nerve^{1,7} whereas in the rest of the studies included in our analysis, the diagnosis was made clinically, based on the development of hoarse/weak voice following surgery.^{4,8,9} The retrojugular approach was associated with a higher incidence of laryngeal nerve damage (8.1%) than the antejugular approach (2.2%; OR: 3.21, 95% CI: 1.46–7.07, *p*=0.004). No significant heterogeneity was identified among the studies (*p*=0.26, *I*²=25%) and the likelihood of publication bias was low (*p*=0.26). Sensitivity analyses including randomised trials only or studies using laryngoscopy to diagnose laryngeal nerve damage did not reveal different results.

No significant differences in the incidence of hypoglossal (1.3% vs 1.3%; OR: 1.09, 95% CI: 0.31–3.80, *p*=0.89) or accessory nerve damage (1.2% vs 0%; OR: 11.51, 95% CI: 0.59–225.45, *p*=0.11) were identified between the two groups. No significant heterogeneity existed among the studies (hypoglossal nerve: *p*=0.68, *I*²=0%; accessory nerve: not applicable) and the likelihood of publication bias was low (hypoglossal nerve: *p*=0.29; accessory nerve: not applicable).

Six patients (2.1%) treated with the retrojugular approach had persisting nerve damage (all laryngeal nerve) whereas only one patient (0.3%) in the antejugular

approach group sustained injury to the hypoglossal nerve, which persisted during the follow-up period. No significant difference in the incidence of persisting nerve damage was identified between the two groups (OR: 2.96, 95% CI: 0.79–11.15, *p*=0.11). No significant heterogeneity was found among the studies (*p*=0.45, *I*²=0%) and the likelihood of publication bias was low (*p*=0.33).

Stroke/transient ischaemic attack and death

Figure 2 shows forest plots comparing stroke, transient ischaemic attack and mortality rates within 30 days of treatment between the retrojugular and antejugular approach groups. Three patients (0.9%) in the retrojugular approach group and another three (0.7%) in the antejugular approach group developed stroke perioperatively or within 30 days of treatment. The incidence of stroke was not significantly different between the groups (OR: 1.26, 95% CI: 0.31–5.21, *p*=0.75). No significant heterogeneity existed among the studies (*p*=0.73, *I*²=0%) and the likelihood of publication bias was low (*p*=0.96).

The incidence of transient ischaemic attack within the perioperative period in the retrojugular and antejugular approach group was 1.8% and 2.1% respectively. It was not significantly different between the two groups (OR: 0.89, 95% CI: 0.21–3.80, *p*=0.87).

Two patients (0.6%) in the retrojugular approach group and another two patients (0.5%) in the antejugular approach group died within 30 days of treatment; the difference between the groups was not different (OR: 1.28, 95% CI: 0.25–6.50, *p*=0.77). No significant heterogeneity

Figure 1 Forest plots of comparison of laryngeal nerve damage (A), hypoglossal nerve damage (B), accessory nerve damage (C) and persistent nerve damage rates (D) between the retrojugular and antejugular approach groups

Figure 2 Forest plots of comparison of stroke (A), transient ischaemic attack (B) and mortality rates within 30 days of treatment (C) between the retrojugular and antejugular approach groups

was identified among the studies ($p=0.70$, $I^2=0\%$) and the likelihood of publication bias was low ($p=0.89$).

Discussion

The internal jugular vein is the anatomic landmark in carotid artery surgery. Proponents of the retrojugular approach for CEA emphasise the shorter operative time and ease of dissection, especially in high carotid lesions.^{3,4} The carotid artery can be exposed without division of any major branches of the internal jugular vein and lymphatic structures are avoided with this technique. Furthermore, the internal carotid artery is encountered in a plane superficial to the external carotid artery and a high exposure of the

vessel may be achieved without mobilisation of the hypoglossal nerve.

Despite the aforementioned advantages, scepticism exists with regard to the safety of this approach because an increased incidence of nerve damage has been described to be associated with the retrojugular plane of dissection of the carotid artery. In the few existing publications, controversial opinions as to the benefits of this method have been expressed. Our objective was to review the pertinent literature and analyse published outcomes. A summary of the evidence is provided, on which clinical implementation and perspective for future research can be based.

Incidence of true cranial nerve injury during the conventional approach for CEA varies widely in the published

studies.^{10,11} A literature review published in 2007 showed an overall rate of 8.3% in a total population of 7,324 patients treated with CEA.¹² Nerves in the vicinity of the internal jugular vein that are at risk during carotid exposure are the hypoglossal, vagus, accessory and facial nerve. Our analyses revealed increased rates of laryngeal nerve damage in patients operated on with the retrojugular approach whereas the risk of injury to the accessory or hypoglossal nerve was not found to be different in the two groups.

Hoarseness of voice is the clinical manifestation of damage to branches of the vagus nerve supplying motor function to the larynx. Possible causes of hoarse or weakened voice are damage to the recurrent laryngeal nerve as it runs into the tracheo-oesophageal groove by a deeply placed self-retaining retractor or inadvertent injury to the superior laryngeal nerve (or its external laryngeal branch) as it descends close to the superior thyroid artery. Inconsistency in the diagnostic methods of laryngeal nerve damage existed among the studies, with some authors using laryngoscopy and others basing their diagnosis on the presence of postoperative development of hoarseness of voice. Stehr *et al* had to stop their RCT after a significant increase in temporary ipsilateral vocal cord motility dysfunction in the retrojugular access group was noticed at the first interim evaluation of 101 patients.⁷

Unlike the antejugular approach, high exposure of the internal carotid artery does not require mobilisation of the hypoglossal nerve with the retrojugular approach, thereby reducing the risk of damage.⁴ This was not verified by our results; hypoglossal nerve injury had an equal distribution between the retrojugular and antejugular group, and was noticed in 1.3% of our meta-analysis patient cohort.

The accessory nerve has also been reported to be at particular risk of damage with the retrojugular plane of dissection in CEA, along its course downward and laterally into the sternocleidomastoid muscle.^{13,14} Transient accessory nerve injury occurred in only three patients in the retrojugular approach group whereas none of the antejugular approach patients was reported to have developed such damage and no significant difference between the two groups was identified. Most nerve injuries reported in the studies were transient, with a small proportion persisting during the follow-up period. The overall incidence of persistent nerve injury was 1.1% and no significant differences were identified between the groups.

Similar to the risk of cranial nerve damage, adverse cerebrovascular events occurring within the perioperative period did not differ between the two groups. It seems that the retrojugular or antejugular dissection plane for CEA does not have an impact on the neurological morbidity or overall mortality risk in these groups of patients.

Study limitations

Our analysis is limited by the fact that it was based on a few studies including a small number of patients. Large numbers of patients would be required to produce meaningful comparisons with regard to rare events such as cranial nerve damage. Study design varied widely and the methodological quality of the RCTs was low. Data regarding cranial

nerve injury were not collected prospectively and consistently in all studies. Furthermore, heterogeneity in the operative (conventional vs eversion endarterectomy, routine vs selective shunting) and anaesthetic methods (general vs locoregional anaesthesia) existed among the studies included in the analysis, which could affect the perioperative outcomes. Inconsistency in diagnostic or reporting methods was noticed; consequently, it is difficult to reach meaningful conclusions regarding the comparative efficacy of the two approaches for CEA.

Conclusions

Potential benefits of the retrojugular approach are compromised by the increased incidence of local nerve complications, specifically laryngeal nerve damage, delaying patient recovery and adding to the overall morbidity. The mechanism of injury is usually traction or injudicious use of diathermy or ligation for haemostasis rather than division. Awareness of the risks associated with the retrojugular approach and meticulous operative techniques may help reduce or eliminate nerve complications. Such measures should be implemented before this approach is widely adopted in carotid artery exposure for carotid endarterectomy. Currently, there is no conclusive evidence to favour one approach over the other. Proof from a large and carefully designed RCT would help determine the role of the retrojugular approach in CEA techniques.

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