Eur J Vasc Endovasc Surg (2017) ■, 1–16

REVIEW

Cranial Nerve Injury After Carotid Endarterectomy: Incidence, Risk Factors, and Time Trends

J.D. Kakisis *, **C.N. Antonopoulos, G. Mantas, K.G. Moulakakis, G. Sfyroeras, G. Geroulakos**

Department of Vascular Surgery, "Attikon" Hospital, Medical School, National and Kapodistrian University of Athens, Athens, Greece

WHAT THIS PAPER ADDS

This meta-analysis summarises the available data on cranial nerve injuries from four randomised, eight prospective, and 14 retrospective studies, corresponding to 20,860 carotid endarterectomies. The results of the meta-analysis indicate that the incidence of cranial nerve injuries has significantly decreased from about 8% to <2% over the past 35 years. Fewer than one seventh of these injuries are permanent. These findings put the problem of post-carotid endarterectomy cranial nerve injury into a new perspective. Cranial nerve injuries should not be considered as a major influencing factor in the decision making process between carotid endarterectomy and stenting.

Objective/Background: Τo review the incidence of post-carotid endarterectomy (CEA) cranial nerve injury (CNI), and to evaluate the risk factors associated with increased CNI risk.

Methods: The study was a meta-analysis. Pooled rates with 95% confidence intervals (CIs) were calculated for CNIs after primary CEA. Odds ratios (ORs) were calculated for potential risk factors. A fixed-effects model or a random effects model (Mantel–Haenszel method) was used for non-heterogeneous and heterogeneous data, respectively. Meta-regression analysis was performed to examine the influence of publication year upon CNI rate.

Results: Twenty-six articles, published between 1970 and 2015, were included in the meta-analysis, corresponding to 20,860 CEAs. Meta-analysis revealed that the vagus nerve was the most frequently injured cranial nerve (pooled injury rate 3.99%, 95% CI 2.56–5.70), followed by the hypoglossal nerve (3.79%, 95% CI 2.73–4.99). Fewer than one seventh of these injuries are permanent (vagus nerve: 0.57% [95% CI 0.19–1.10]; hypoglossal nerve: 0.15% [95% CI 0.01–0.39]). A statistically significant influence of publication year on the vagus and hypoglossal nerve injury rate was found, with the injury rate having decreased from about 8% to 2% and 1%, respectively, over the last 35 years. Urgent procedures (OR 1.59, 95% CI 1.21–2.10; $p = .001$), as well as return to the operating room for a neurological event or bleeding (OR 2.21, 95% CI 1.35–3.61; $p = .002$) were associated with an increased risk of CNI, whereas no statistically significant association was found between CNIs and the type of anaesthesia, the use of a patch, redo operation, and the use of a shunt.

Conclusion: The vagus nerve appears to be the most frequently injured cranial nerve after CEA, followed by the hypoglossal nerve, with only a small proportion of these injuries being permanent. The CNI rate has significantly decreased over the past 35 years to a point indicating that CNIs should not be considered a major influencing factor in the decision making process between CEA and stenting.

Article history: Received 28 July 2016, Accepted 12 December 2016, Available online XXX

Keywords: Carotid, Cranial nerve injury, Endarterectomy, Meta-analysis, Risk factors, Time trend

INTRODUCTION

Carotid endarterectomy (CEA) is associated with a number of serious complications, with stroke, death, and myocardial infarction being the main endpoints of all relevant studies. Cranial nerve injuries (CNIs) have received considerably less attention, despite the fact that they are quite frequent and potentially serious; they may even be life threatening when they are bilateral. Although it has been more than 40 years since CNIs after CEA were first described, several questions remain unanswered regarding the incidence, predictors, and the management of such injuries.[1,2] The reported incidence of CNIs after CEA ranges widely from 2% to >50%, depending mainly on the different investigative methods

* Corresponding author. Department of Vascular Surgery, Attikon University Hospital, 1 Rimini Street, Haidari, Athens 12462, Greece.

E-mail address: kakisis@med.uoa.gr (J.D. Kakisis).

http://dx.doi.org/10.1016/j.ejvs.2016.12.026

used for the evaluation of cranial nerve function.[3,4] Most of these nerve injuries are transient, being due to neuropraxia caused by excessive retraction. Thus, prevention is better than cure, especially as there is no specific and effective therapy.

CNIs have gained renewed interest over the last 15 years as they have become a point of comparison between CEA and carotid stenting (CAS) and have been defined as a secondary outcome in most recent CEA versus CAS trials.[5–8] Moreover, there has been a continuing claim by interventionalists supporting CAS that CNIs should be included in the composite endpoint of trials comparing CEA with CAS, as their clinical impact is similar to a minor stroke. This claim, however, has been challenged, as the incidence of a permanent or disabling CNI is very low and should not detract from the significant benefit conferred by CEA regarding stroke prevention.[9]

The aim of this study was to review the incidence of post-CEA CNI, to evaluate the risk factors associated with increased CNI risk, and to examine whether the incidence of CNI has changed over the past few decades.

MATERIALS AND METHODS

Data collection

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used in the current study.[10] The following medical literature databases were searched systematically: MEDLINE, Scopus, Embase, Google Scholar, Ovid, and the Cochrane Library. After retrieving the relevant articles, a snowball process in the reference list of eligible articles was followed to retrieve additional articles, which were, thereafter, included if they satisfied the inclusion criteria.

Search methodology, inclusion and exclusion criteria, data extraction

The following Medical Subject Headings (MeSH) terms were used: ("cranial" [All Fields] OR "brain" [All Fields]) AND ("endarterectomy" [All Fields]) AND ("nerve" [All Fields]) AND ("carotid" [All Fields]). All scientific papers between January 1970 and December 2015 were searched for, without sex or language restriction. Studies focusing on CNI after primary CEA were investigated. Studies reporting on CNIs after repeat CEA were excluded. Studies that did not report numbers of CNI in patients after CEA were also excluded. Data were independently extracted and analysed by two authors (J.D.K., C.N.A.) and the final decision was reached by consensus. Data extracted from eligible studies included the first author's name, study year, country in which the study was conducted, total number of patients, total number of CEAs, number of CNIs, study period, type of study, male sex (%), mean age (years), description of oto-rhinolaryngologist's examination, definition of neurological assessment, type of CEA technique, shunt use (%), and risk factors for CNI, as reported by the authors. Numbers for CNIs of facial (VII), glossopharyngeal (IX), vagus (X), spinal accessory (XI), hypoglossal (XII), and important nerve branches, namely marginal mandibular and great auricular, were extracted separately. The total number of CNIs (either transient or permanent) for each nerve, as well as the number of permanent CNIs, was also extracted separately.

Statistical analyses

Data synthesis and treatment effects. The CNI rates in patients after CEA were estimated for each cranial nerve studied and reported as the proportion of corresponding nerve injuries among all CEAs. Values of the concomitant injuries were subsequently appropriately calculated, expressed as proportions and 95% confidence intervals (CIs) and thereafter transformed into quantities according to the Freeman—Tukey variant of the arcsine square root transformed proportion. The pooled effect estimates were calculated as the back transformation of the weighted mean of the transformed proportions, using DerSimonian—Laird weights of random effects model and expressed as proportions (%).[11]

A second meta-analysis was performed, aiming to investigate the potential role of clinical risk factors found in the eligible studies, namely urgent CEA, local anaesthesia, use of patch, redo operation, return to the operating room for a neurological event or bleeding, and use of shunt on CNI during CEA, and was based on the available data extracted of the total number of patients and patients with and without the risk factor from each study. Thereafter, odds ratios (ORs) with corresponding CIs were appropriately calculated from 2 × 2 tables or directly extracted from the results of multivariate analyses reported in the eligible studies. A pooled estimate of ORs, together with the corresponding 95% CIs, was then calculated. A fixed effects or a random effects model (Mantel—Haenszel method) was used for non-heterogeneous or heterogeneous data,

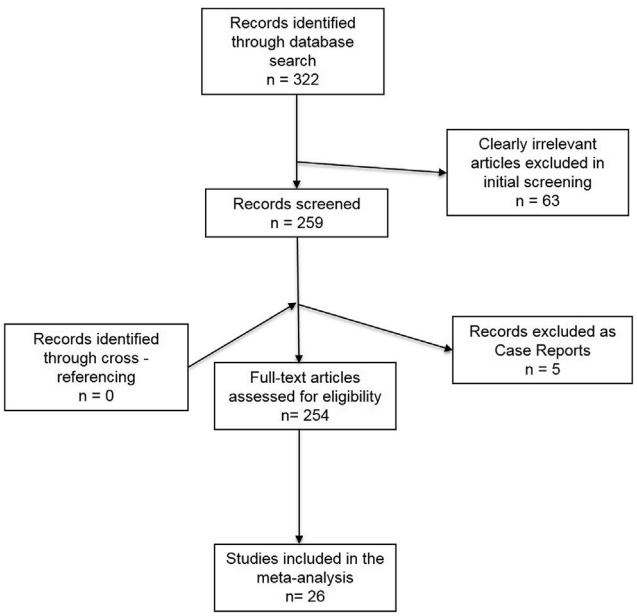

Figure 1. Flowchart presenting the selection of eligible studies.

Please cite this article in press as: Kakisis JD, et al., Cranial Nerve Injury After Carotid Endarterectomy: Incidence, Risk Factors, and Time Trends, European Journal of Vascular and Endovascular Surgery (2017), http://dx.doi.org/10.1016/j.ejvs.2016.12.026