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Review

A Systematic Review of the Cervical Plexus Accessory Innervation and Its Role in Dental Anesthesia

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ABSTRACT

Introduction: Accessory innervation (AI) may account for the persistent sensation perceived after successful mandibular anesthesia in the adult patient. The purpose of this systematic review was to record the quality of evidence pertaining to the cervical plexus (CP) AI in dental anesthesia.
Materials and methods: Electronic and manual searches were conducted using Ovid and Medline of articles published from 1922 to March of 2015. Studies written in any language were included as long as they involved: (i) humans, animals, and/or cadavers AND (ii) anatomical and/or research anesthetic-technique approaches and/or clinical approaches. Exclusion criteria were (i) maxillary buccal infiltration, (ii) no abstract/paper available, (iii) studies that do not comprise the description of the branches of the CP branches in dentistry and (iv) duplicated articles. The articles were reviewed and graded by levels of evidence (LOE) through a methodological scoring index (MSI).
Results: Forty-four out of 185 papers fulfilled the inclusion criteria. One randomized control trial, 3 comprehensive reviews, 1 cohort study, 5 case series/reports, 16 poor-quality cohort and case series/reports and 18 reviews/case, reports/expert opinions were found. Of the 44 publications, there were 4 LOE 1, 1 LOE 2, 5 LOE 3, 20 LOE 4 and 14 LOE 5 studies.
Conclusions: The MSI helped to classify papers LOE in a standardized and objective approach. The objective evidence quality occurrence recorded was found to be LOE 4 (n = 20) > LOE 5 (n = 14) > LOE 3 (n = 5) > LOE 1 (n = 4) > LOE 2 (n = 1). The anatomy of the CP needs to be reexamined and understood in the anatomical literature.

Introduction

Since the development of the first commercial dental anesthetic in 1905, one of the most critical steps in dentistry has been the administration of a reliable local anesthetic technique in order to block or infiltrate with an anesthetic solution the nerve and its pain pathway.[1] Depending on the location of the dental procedure, local anesthetic may be delivered to the anterior, middle and posterior superior alveolar nerves; the infraorbital, nasopalatine and greater palatine nerves in the maxillary region; and the inferior alveolar nerve (IAN), auriculotemporal, buccal (long buccal and buccinator), mental, incisive, mylohyoid and lingual nerves in the mandibular area. For these purposes, descriptions of routine techniques have been proposed for maxillary and mandibular regional anesthesia.[2–4] A clinical dilemma that occurs too often is inadequate anesthesia despite correctly administering an IAN, which is certainly disconcerting when a patient is in the dental chair and expects a painless operative procedure.[5–8]

In a survey of 93 general practitioners, 13% of their local anesthetic techniques failed; 88% of the failures occurred with the IAN block.[9] Other studies also highlighted this pain management issue in (1) root canal procedures (45% of IAN blocks failed),[10] (2) lower molar extractions (anesthetic failure rates of 10.7% for IAN blocks and 17.8% for Akinosi technique),[11] and (3) implant drilling and suturing on the edentulous posterior mandibular ridge (14.2% of IAN blocks failed.).[12]

A number of theories have been advocated in order to explain this phenomenon including the central core theory, decreased pH of inflamed tissues, nerve-altered resting potentials, anesthetic-resistant sodium channels and patient dental anxiety.[13,14] Recent studies in clinical anatomy suggest that the theory of accessory innervation may be the most plausible reason for this problem.[7,8,15,16] The theory

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of accessory innervation to the IAN advocates that incidents of unsuccessful anesthesia may result from innervations of the mandible arising from the cervical plexus (CP) in addition to the auriculotemporal, buccal, mental, incisive, mylohyoid, and lingual nerves.[2–8,14,15,17–25] The theory of accessory innervation has not been universally accepted due to the lack of anatomical evidence demonstrating that nerves from the cervical plexus can extend to the mandible.[3,4] Previous research has highlighted that the difficulty in identifying this superficial branch during dissections could be due to the small size and thickness of the mandibular accessory foramina and CP nerves, as well as to the dissection technique used.[5,21,25,26] A 3-dimensional nerve mapping method investigation through human cadavers' microdissection, tissues transparency and nerve staining presented the first recorded evidence of the transverse cervical nerve (TCN) from the CP entering into the mandible.[7] A further microdissection study in 250 human cadavers showed how the TCN and the great auricular nerve (GAN) from the CP reached the mandible in 97% of the cases.[15]

The CP arises from the spinal cord by 2 roots, a dorsal root which supplies sensory fibers and a ventral root which supplies motor fibers, as compared to the cranial nerves that are originated in the skull. The cutaneous branches of the CP cutaneous branches are comprised of the supraclavicular nerve (C3–C4), the lesser occipital (C2), the GAN (C2–C3) and the TCN (C2–C3), which innervates the anterior region of the neck and mandible.[7,15] An updated special issue on the anatomy of cranial nerves was recently published in *Clinical Anatomy*. The reviews concluded that the cranial and cervical nerves with their extraaxial communications could be collectively considered a craniocervical nerve plexus.[27]

Despite these efforts, the evidence and classification of the contribution of the CP in dental anesthesia through the TCN and GAN have not been fully assessed. The purpose of this study was to determine and record the quality of the evidence for the role of CP accessory innervation in dental anesthesia since the role's first description in 1922 and to grade them by levels of evidence based on their implications for anatomy, research, anesthetic techniques and clinical applications.

Material and Methods

Three reviewers (one endodontist (DUF) one oral and maxillofacial radiologist (JY) and one endodontics resident (DK)) used Ovid Medline in-process as well as other non-indexed citations in Ovid Medline, PubMed and a manual search to retrieve abstracts and published papers from January of 1922 to March of 2015. Search combinations of the following MeSH subject headings were used: cervical plexus, buccal infiltration, dentistry, transverse cervical nerve, cutaneous colli and teeth, greater auricular nerve and mandible, and transverse cervical nerve and mandible. Every effort was made to validate the papers within the reviews as far back as 1889 by conducting a manual search. Using this method, 185 articles were selected for review.

The articles and abstracts were reviewed by each team member based on the agreed upon inclusion and exclusion criteria. Studies written in any language were included as long as they involved: (i) humans, animals, and/or cadavers AND (ii) anatomical and/or research anesthetic-technique approaches and/or clinical approaches pertaining to role of the cervical plexus in dentistry. Exclusion criteria were (i) maxillary buccal infiltration, (ii) unavailability of abstract/paper, (iii) studies that did not comprise the description of the cervical plexus nerve in dentistry and (iv) duplicate articles. Abstracts and articles in non-English languages were translated using Microsoft Office Proofing Tools 2003 software (Microsoft Corporation, Redmond, WA) or through a translator fluent in the language of the article. The selection of articles, the decisions about eligibility and data extraction were conducted independently by 3 reviewers following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement.[28] Any disagreement was settled through discussion until a consensus was reached.

Table 1
Point assignments following the methodological scoring index

Methodology Index	Score
Comprehensive search of the literature/MeSH term headings/ inclusion/exclusion/levels of evidence	15 points
Randomization	6 points
Cohorts exposure and no exposure	5 points
Experimental and Control group	4 points
Statistical analysis	3 points
Series of patients presenting a specific disease	2 points
Interpretation of the subject by experts	1 point

The abstracts and full articles were then retrieved and forwarded to each of the 3 reviewers. These articles were read thoroughly and jointly stratified based upon point assignments through a methodological scoring index (MSI). The MSI was developed and implemented to standardize the classification process and to help achieve an objective review (Tables 1 and 2). Papers were classified by levels of evidence (LOE) as shown in Table 2.

Results

Of the initial 185 papers found through our systematic search, 30 were duplicates. An additional 2 publications (Nevin M, Nevin H. Problems in Dental Local Anaesthesia. Second edition. Brooklyn, NY: Dental Items of Interest Pub. Co.; 1954, and Testut L. 1902. *Tratado de Anatomia Humana*, Tomo tercero, Sexta edicion. Barcelona: Salvat and Son; 1902.) were irretrievable through the authors' library resources.

Out of the remaining 153 papers selected for review, 44 publications met the inclusion criteria. Of these included studies, analysis revealed one randomized control trial, 3 comprehensive reviews, one cohort study, 5 case series/reports, 16 poor-quality cohort and case series/reports and 18 reviews/case reports/expert opinions. The PRISMA flow diagram (Fig. 1) summarizes the results of our search.

Of the 44 publications, there were 4 LOE 1, 1 LOE 2, 5 LOE 3, 20 LOE 4 and 14 LOE 5 studies. Tables 3 and 4 summarize the LOE for the articles individually and grouped. Point assignments showed 14 studies with scores of 1, 18 studies with scores of 2, 2 studies with scores of 5, 2 studies with scores of 6, 3 studies with scores of 7, 1 study each with a score of 11 and 13, and 3 studies with scores of 15. Table 5 summarizes the MSI.

Discussion

Manual search validation helped to retrieve the first anatomical record of a nerve originating from the CP reaching the mandible in 1889[29] Traite de anatomie descriptive figure no. 575 (Fig. 2).

Table 2
Level of evidence based on the methodological scoring index totals

Level of Evidence	Study Type	Methodological Scoring Index Sum
LOE 1	Randomized control trials (RCTs) or Meta-analysis or systematic reviews of RCTs	13-15 points
LOE 2	Cohort studies, systematic reviews of cohort studies and outcomes research	9-12 points
LOE 3	Case–control studies and systematic reviews of case–control studies	6-8 points
LOE 4	Poor-quality cohort and case control studies and case series	2-5 points
LOE 5	Case reports and expert opinion without explicit critical appraisal	1 point