Review

Facial paralysis after intraoral anesthetic injection: A systematic review

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Abstract

Many complications can occur after the injection of local intraoral anesthetics (ILIA) before dental intervention. Facial paralysis (FP) is one of these complications. The purpose of this study was to systematically analyze the association between ILIA and FP. A systematic review was carried out taking into account the methodology of the Cochrane Handbook for Systematic Reviews of Interventions and the PRISMA statement. The search strategy used "Palsy AND Facial" and "Paralysis AND Facial" as search terms. The ScienceDirect, PubMed and Scopus databases were searched using the "dentistry journal" filter. The inclusion criteria included studies describing FP after or during ILIA that were published in dental journals. The CAse REports (CARE) checklist was applied in evaluating the methodological quality of case reports. A total of 2,462 articles (algorithm) were identified. After reviewing titles and abstracts, 18 articles were deemed relevant taking into account the objectives of this study. Only 13 of them, after reading the full text, met the inclusion criteria and were analyzed. Case reports on 18 cases of FP were analyzed, 12 of which described the early development of FP (onset within 24 h) and 6 the late development (onset after 24 h). Acceptable compliance with CARE guidelines was observed in the included studies . Early FP CRs presented the effect of the administered anesthetic on the facial nerve, and the vascular effect of the vasoconstrictor included in the anesthetic formula, while more recent FP CRs focused on the reactivation of herpes simplex virus type 1 (HSV-1), human herpesvirus 6 (HHV-6) or varicella-zoster virus (VZV).

Keywords: local anesthetics, systematic review, anesthesia, Bell's palsy, facial paralysis

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Introduction

The scientific literature describes a wide range of clinical complications following the injection of local intraoral anesthetics (ILIA), which can be divided into 2 groups: systemic and local complications. Allergic reactions, toxicity and methemoglobinemia, among others, are listed in the systemic group, whereas ocular complications, trismus of the masticatory muscles, pain, infection, paresthesia, and facial paralysis (FP) constitute the local group.[1] In FP, the patient is unable to move the muscles of expression of the affected side, causing insufficiency in the labial functions and ocular closure, which impairs the quality of life of the patients and their relatives.[2] Among known types of FP, idiopathic facial paralysis (IFP), also known as Bell's palsy, has been studied most intensively. It has the same characteristics as FP, but its onset is sudden, without a clear etiological factor.[3] Recently, Zhang et al. summarized the possible clinical etiologies of IFP, including viral infection, ischemia, immune inflammation, exposure to cold, and various anatomical conditions of the facial nerve.[4] However, there is little information from a dental point of view on how intraoral anesthesia techniques or used anesthetic can cause FP.[5] The objective of this study was to analyze the association between ILIA and FP by means of a systematic review of scientific dental literature.

Material and methods

The method used was adapted from the Cochrane Handbook for Systematic Reviews of Interventions[6] and the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement for systematic reviews.[7]

The following question was used for the organization of this study: Is there scientific evidence of FP after ILIA in dental care? This allowed the descriptions of the Population (P), Intervention (I), Comparison (C), and Outcomes (O) to be obtained (the PICO framework).

1. Population: Adult patients without baseline central or peripheral nervous system disorders.
2. Intervention: ILIA.
3. Comparison: There was no comparison since there are hardly any records regarding ILIA without complications.
4. Outcome: FP subsequent to ILIA.

Search strategy

In the search strategy, the following terms: "Palsy AND Facial" and "Paralysis AND Facial" were used to search the ScienceDirect, PubMed and Scopus databases. A restriction date of August 2019 and a search filter "only dental journals" was used to find studies whose aim was to understand the association of FP with ILIA and treatment of FP after ILIA.

Inclusion and exclusion criteria

The inclusion criteria were as follows: 1) studies that report FP attributable to ILIA in dental care; 2) case report (CR) studies; 3) studies published in dental journals; and 4) studies on humans.

The following publications were excluded: 1) studies of FP following orthognathic surgery; 2) studies of FP following parotid gland removal; 3) studies of FP caused by condylar process fracture treatment; 4) studies of FP due to factors other than ILIA; 5) book chapters; and 6) animal studies.

Screening process

Two independent reviewers searched the databases, removed duplicate articles from the list of papers they created, read titles and abstracts to identify papers not relevant to the research topic, and finally read full texts of selected articles to verify compliance with the inclusion criteria. Differences between the 2 reviewers were resolved by a 3rd team member.

Data extraction

Two reviewers independently collected the following data from the analyzed studies: authors, year of publication, type of study, number of cases reported, sex and age of patients, time of onset of FP, FP classification, anesthetic used, anesthetic technique, affected side, dental treatment performed, treatment provided for FP, degree of recovery, and recovery time.

Assessment of methodological quality

For the evaluation of the methodological quality of the case CRs, the CAse REports (CARE) checklist (https://www.care-statement.org/checklist) was used.[8] Although this checklist was designed as a guide for the elaboration of CRs, the lack of guidelines for assessing the methodological quality of this type of study makes the use of CARE necessary. A quantitative analysis was performed, in which each affirmative question from CARE checklist was assigned 1 point, while each negative answer was assigned a value of 0. In addition, 3 levels of methodological quality were established according to the total sum of points for a given study: poor (0–15), acceptable (15–22) and excellent (23–30). We required at least a value of 50% (15 points) or greater of the total possible score for a study to be classified as acceptable, and more than 70% (22 points) positive responses to be classified as excellent. The papers were also quantitatively analyzed according to the topics that make up CARE guidelines: Title/Keywords, Abstract, Introduction, Patient Information, Clinical Findings, Timeline, Diagnostic Evaluation, Therapeutic Intervention, Follow-up and Outcomes, Dis-

cussion, Patient Perspective, and Informed Consent. Finally, a qualitative analysis using the CARE checklist was performed.

Results

A total of a total of 3,301 articles were identified in the 3 searched databases: 985 in PubMed, 1,379 in ScienceDirect and 937 in Scopus. This number was reduced to 2,462 after the elimination of duplicate articles. Subsequently, the titles and abstracts were read to assess whether the papers were relevant to the study subject. Eighteen articles were selected and completely read to verify compliance with the inclusion criteria.

Five articles did not meet the selection criteria and were eliminated for the following reasons: 1) FP occurred immediately after an inappropriate surgical procedure (air blast performed with a triple syringe to visualize the surgical bed)[9]; 2) case report without information required for analysis[10]; 3) a retrospective study that analyzed the reactivation of varicella-zoster virus (VZV) in delayed FP after dental treatment and orofacial surgery in patients who presented with FP 20 days after dental treatment.[11]; 4) FP attributed to endodontic treatment of lower right molar[12]; and 5) intervention was performed under general anesthesia[13] (Table 1). Finally, 13 articles (Fig. 1) were included in this systematic review, with a total of 18 cases analyzed (Table 2).[14–26]

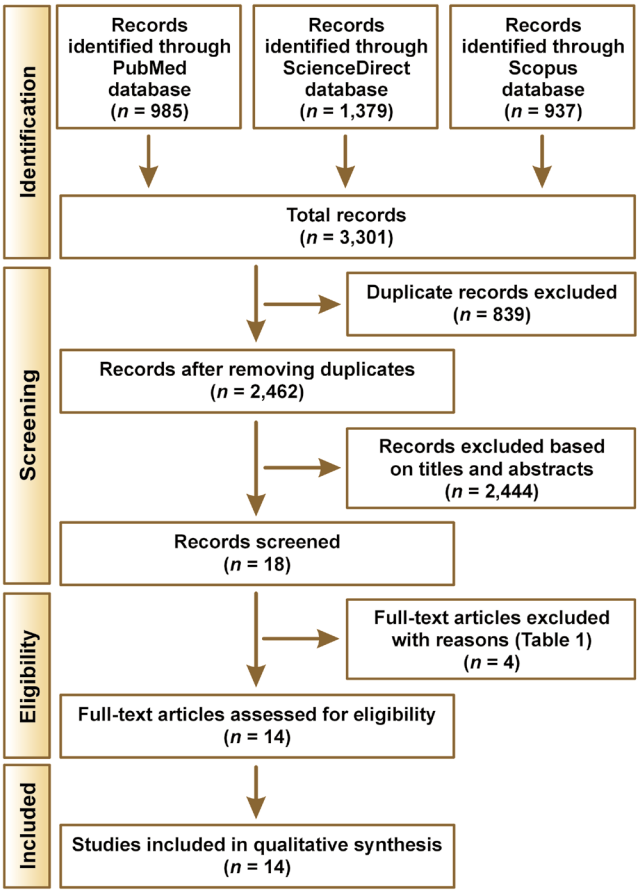

Fig. 1. Flowchart of the selection studies

Generic analysis of the studies

Of the 13 articles included in this review, 9 were CRs,[14–18,20,21,24,25] 3 CRs and literature reviews,[19,22,23] and 1 a CR in a form of a letter to the editor.[26] One study reported 4 cases,[15] 2 studies reported 2 cases each[19,21] and 10 studies reported 1 case each.[14,16–18,20,22–26] In the 18 cases analyzed, the sex distribution of the treated patients was as follows: in 9 cases, the patients were women,[15,22–26] in 7 cases men[16–21] and in 1 case there was no information on sex.[14] In relation to the age of the treated patients, 17 cases reported this data[15–26] and 1 case did not.[14] The mean age of treated patients was 34.25 years with a minimum age of 16 years and a maximum age of 62 years.

In relation to the anesthetic technique used in analyzed cases, it was observed that the truncal technique of an inferior alveolar nerve block (IANB) was employed in 11 cases,[14–25] while in 4 cases, other types of IANB technique were chosen: with infiltration of anesthetic on the buccal nerve,[21] with infiltration of anesthetic at the level of the upper central incisor on the same side,[19] with infiltration of vestibular anesthesia at the level of the upper third molar,[26] and with infiltration of vestibular anesthesia in relation to the first upper premolar law.[25] In 2 cases, the anesthetic technique used was not reported.[18,21] In relation to the type of anesthesia used, it was observed that lidocaine was chosen in 9 cases,[14–17,19,20,22] articaine in 5,[21,24–26] mepivacaine in 1,[23] and in 2 cases, the used anesthetic was not reported.[18,21] The sides being anesthetized were

Table 1. Excluded studies

Study	Reason for exclusion
Burke and Adams, 1987[9]	Facial paralysis (FP) occurred after the application of a burst of compressed air to visualize surgical area.
Stoy and Gregg, 1951[10]	Case report without information required for analysis.
Furuta et al., 2000[11]	A retrospective study that analyzed the reactivation of varicella-zoster virus (VZV) in delayed FP after dental treatment and orofacial surgery in patients who presented with FP 20 days after dental treatment.
Demetoglu et al., 2016[12]	Facial paralysis occurred after endodontic treatment of the first right lower molar, then exodontia of this tooth was performed and the paralysis disappeared.
Bobbitt et al., 2000[13]	Intervention was performed under general anesthesia.

Table 2. Characteristics of included studies

Study	Study type	Number of cases reported	Sex	Age [years]	Anesthetic and vasoconstrictor	Anesthesia technique	Affected side	Dental treatment performed	Time of onset of FP	FP classification	Recovery (total, partial or no recovery)	Recovery time [days]
Tiwari and Keane 1970[14]	case report	1	not reported	not reported	lidocaine adrenalin	IANB	left	dental surgery (accomplished)	night after the treatment	early	total	38
Gray 1978[15]	case report	4	F	44	lidocaine not reported	IANB	left	dental surgery (accomplished)	3 min after anesthesia application	early	total	1 (2 h)
			F	29	lidocaine not reported	IANB	left	dental surgery (accomplished)	3 min after anesthesia application	early	total	1 (7 h)
			F	16	lidocaine not reported	IANB	left	dental surgery (accomplished)	2 min after anesthesia application	early	total	1 (1.5 h)
Weinberg et al. 1985[16]	case report	1	M	50	lidocaine adrenalin	IANB	left	lower canine endodontic treatment (not accomplished)	11 min after anesthesia application	early (right side)	total (right side)	1 (55 min)
Ling 1985[17]	case report	1	M	22	lidocaine epinephrine	IANB	left	impacted lower third molar surgical exodontia impacted (accomplished)	20 days after treatment	late	total	30
Shuaib and Lee 1990[18]	case report	1	M	26	not reported	not reported	right	lower third molar exodontia (accomplished)	within 24 h after treatment	early	total	44
Miles 1992[19]	case report and review	2	M	26	lidocaine adrenalin	IANB and infiltration to superior alveolar nerve	right	dental surgery (first lower right molar and upper central incisor) (accomplished)	4 days after treatment	late	total	30
Shenkman et al. 1996[20]	case report	1	M	34	lidocaine epinephrine	IANB	right	dental surgery (amalgam) (accomplished)	20 min after treatment	early	without recovery	not applicable
Tazi et al. 2003[21]	case report	2	M	40	articaine epinephrine	IANB and infiltration to buccal nerve	right	lower third molar exodontia (accomplished)	20 days after treatment	late	total	150
			M	42	not reported	not reported	right	upper first molar exodontia (accomplished)	24 h after treatment	late	partial	31
Vasconcelos et al. 2006[22]	case report and review	1	F	21	lidocaine epinephrine	IANB	right	lower third molar exodontia (accomplished)	morning after treatment	early	total	90
Chevalier et al. 2010[23]	case report and review	1	F	34	mepivacaine without vasoconstrictor	IANB	left	lower second molar pulpotomy (accomplished)	2 h after treatment	early	total	365
Tzermpos et al. 2012[24]	case report	1	F	20	articaine adrenalin	IANB	left	dental surgery (lower first molar) (accomplished)	24 h after treatment	late	total	60
Ilea et al. 2014[25]	case report	2	F	62	articaine adrenalin	IANB	left	lower first molar pulpectomy (not accomplished)	2 min after anesthesia application	early	total	1
			F	59	articaine adrenalin	IANB and infiltration to middle superior alveolar nerve	right	vestibular drainage at the level of the first premolar (accomplished)	on the day after treatment	early	total	21
Zhang et al. 2016[26]	case report letter to editor	1	F	23	articaine not reported	IANB and infiltration to posterior superior alveolar nerve	right	upper third molar exodontia (not accomplished)	immediately after anesthesia application	early	total	1 (2 h)

FP – facial paralysis; IANB – inferior alveolar nerve block; F – female; M – male.

8 right and 9 left, and the affected sides were 8 right and 9 left, resulting in 17 reports of FP on the same anesthetized side (ipsilateral side), and a single report on the other side (contralateral side).[14–26] Furthermore, out of the 17 reported cases, 12 displayed early FP within 24 h[14–16,18,20,22,23,25,26] and the remaining 5 late FP.[17,19,21,24] Only 9 patients received some type of treatment of FP,[14,17,18,20–24] such as corticosteroids in 5 reports,[14,17,18,21,24] nonsteroidal anti-inflammatory analgesics (NSAIDs) in 1,[20] NSAIDs with an antibiotic (amoxicillin) and vitamin B complex in 1,[25] and vitamin B, cytidine and uridine complexes in 1.[22] Finally, it was observed that 15 patients achieved full recovery, 1 partial recovery and 1 no recovery. The mean recovery time from FP was 54.1 days, with a minimum and maximum time of 45 min and 365 days, respectively. The cases in which the recovery time was shorter than 7 h were approximated as 1 day to calculate the mean time in days. Detailed characteristics of each included study and case are presented in Table 2.

Analysis of the methodological quality of the included studies

According to the CARE guidelines and the criteria described in the Materials and methods section, the methodological quality of the CRs included in this review was generally acceptable, with a mean value of 15.5 (52%). In the analysis of the CRs on a case-by-case basis, 12 scored 50% or more of positive answers and were classified as acceptable, and 5 failed to exceed 50% and thus were classified as poor. No case in any paper scored more than 70% of positive responses, and thus none of the cases were classified as having excellent quality. However, when analyzing the methodological quality in relation to the publication year, 5 of 6 cases described in articles published before 1990 had a very low percentage of positive responses (37%, 27%, 23%, 23%, and 47%). This score improved over time, as all analyzed articles published after that date had a score of 50% or more.

Methodological quality analysis in terms of individual topics that make up CARE guidelines yielded the following percentages of positive responses: Title/Keywords – 56%, Abstract – 57%, Introduction – 71%, Patient Information – 57%, Clinical Findings – 88%, Timeline – 82%, Diagnostic Assessment – 34%, Therapeutic Intervention – 57%, Follow-up and Outcomes – 25%, Discussion – 79%, Patient Perspective – 0%, and Informed Consent – 12%.

During the analysis of affirmative answer percentages using the CARE guidelines, the 4 questions that obtained the highest percentages were "Discussion of the relevant medical literature with references" – 100% and "The scientific rationale for any conclusions (including assessment of possible causes)" – 100% (both from the Discussion topic), "Did the patient give informed consent? Please provide if requested" (from the Informed Consent topic) – 100%, and "Introduction: What is unique about this case and what does it add to the scientific literature?" (from the Abstract topic) – 94%. On the other hand, the 4 questions that obtained the lowest percentages were and "Intervention adherence and tolerability (How was this assessed?)" – 6% and "Adverse and unanticipated events" (both from Follow-up and Outcomes topic) – 0%, "Prognosis (such as staging in oncology) where applicable" (from the Diagnostic Assessment topic) – 0%, and "The patient should share their perspective in one to two paragraphs on the treatment(s) they received" (from the Patient Perspective topic) – 0%. The details of the methodological quality analysis are presented in Table 3, and all the questions constituting the CARE guidelines are listed in Table 4.

Discussion

Facial paralysis following ILIA can be classified as early or late, with early cases occurring within the first 24 h, and late cases beginning later than 24 h after ILIA. On the other hand, the length of anesthetic action of lidocaine, mepivacaine and articaine on soft tissues varies from 3 to 5 h,[27] so late FP cannot be caused by the local anesthetic affecting the facial nerve. Possible causes of FP as a consequence of ILIA described in the analyzed studies include: 1) direct effect of the anesthetic solution on branches of the facial nerve, 2) viral reactivation and 3) the vasoconstrictive effect on sympathetic fibers that affects the facial nerve. If the first proposed cause is true, it would mean that the anesthetic solution is deposited directly into the parotid region (PR), which the facial nerve passes after leaving the stylomastoid foramen.[28] Given that the anesthetic does not have the capacity to pass through the fascia that delineates the PR,[29] the anesthetic would need to be deposited near a terminal branch of the facial nerve.

It should be noted that in most of the intraoral anesthesia techniques used in dentistry, anatomical injection sites away from the PR and terminal motor branches of the facial nerve are routinely chosen. However, IANB is the riskiest technique in relation to the possibility of depositing anesthetic in the PR as the anesthetic inoculation site is the pterygomandibular space (PS), which is located close to the PR. The articles included in this systematic review reported that 13 of the 18 FP cases occurred in patients where the IANB technique was used, and only in 5 FP cases, a different or no anesthetic technique was described. Furthermore, among the 13 reported FP cases in which IANB technique was chosen, 9 had early onset, which supports the explanation that the anesthetic is the cause of FP and may have been deposited in the PR in those cases.

One of the possible factors causing anesthetic deposition in the PR could be the deflection of the needle as it passes through the soft tissues until it reaches the anesthetic inoculation area. A deviation of the needle from the expected insertion path can occur. This phenomenon has been studied in needles used in dentistry for performing

Table 3. Characteristics of the selected studies

Topic	Tiwariand Keane 1970[14]	Gray 1978 (a)[15]	Gray 1978 (b)[15]	Gray 1978 (c)[15]	Weinberg et al. 1985[16]	Ling 1985[17]	Shuaib and Lee 1990[18]	Miles 1992 (a)[19]	Shenkman et al. 1996[20]	Tazi et al. 2003 (a)[21]	Tazi et al. 2003 (b)[21]	Vasconcelos et al. 2006[22]	Chevalier et al. 2010[23]	Tzermpos et al., 2012[24]	Ilea et al. 2014 (a)[25]	Ilea et al. 2014 (b)[25]	Zhang et al. 2015[26]	Percentage of positive responses for each question [%]	Percentage of positive responses for each topic [%]
Title	0	1	1	1	0	0	0	1	1	1	1	1	1	0	1	1	1	71	56
Keywords	0	0	0	0	1	0	0	1	1	0	0	1	0	1	1	1	0	41	
Abstract	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	94	57
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	88	
	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	29	
	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	18	
Introduction	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	71	71
Patient Information	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	88	57
	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	77	
	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	18	
	0	0	0	0	0	1	1	0	1	1	1	1	1	0	0	0	1	47	
Clinical Findings	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	88	88
Timeline	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	82	82
Diagnostic Assessment	1	0	0	0	1	1	1	0	1	0	0	1	1	0	1	1	1	59	34
	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	41	
	0	0	0	0	1	0	0	1	1	0	0	1	0	1	0	0	1	35	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Therapeutic Intervention	1	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	0	71	57
	1	0	0	0	1	1	0	1	0	1	1	1	1	1	1	1	0	65	
	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1	1	0	35	
Follow-up and Outcomes	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	24	25
	1	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	71	
	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Discussion	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	18	79
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100	
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100	
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	100	
Patient Perspective	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Informed Consent	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	12	12
Total number of positive responses for each case	11	8	7	7	14	17	16	15	17	18	18	21	21	18	18	18	19	1.5	–
Methodological quality of each study	P	P	P	P	P	A	A	A	A	A	A	A	A	A	A	A	A	A	
Percentage of positive responses for each case [%]	37	27	23	23	47	57	53	50	57	60	60	7	70	60	60	60	63	52	

A – acceptable; P – poor; 0 – negative answer; 1 – positive answer.

ILIA, with a maximum deviation of 8.4 mm and 5.2 mm from the expected insertion path in the studies reported by Jeske and Boshart[30] and Hochman and Friedman,[31] respectively. On the other hand, it has also been shown that the bevel of the needle influences the deviation of the needle as it passes through the tissues, generating a deviation to the opposite side to the one on which it is located.[32–35] It could mean a deviation of the needle towards

Table 4. CAse REports (CARE) checklist questions

Topic	Check list item description
Title	1. The words "case report" should be in the title along with the area of focus.
Keywords	2. Two to five key words that identify areas covered in this case report.
Abstract	3. (a) Introduction. What is unique about this case? What does it add to the medical literature?
	3. (b) The main symptoms of the patient and the important clinical findings.
	3. (c) The main diagnoses, therapeutics interventions, and outcomes.
	3. (d) Conclusion: What are the main "take-away" lessons from this case?
Introduction	4. One or two paragraphs summarizing why this case is unique with references.
Patient Information	5. (a) De-identified demographic information and other patient specific information.
	5. (b) Main concerns and symptoms of the patient.
	5. (c) Medical, family, and psychosocial history including relevant genetic information (also see timeline).
	5. (d) Relevant past interventions and their outcomes.
Clinical Findings	6. Describe the relevant physical examination (PE) and other significant clinical findings.
Timeline	7. Important information from the patient's history organized as a timeline.
Diagnostic Assessment	8. (a) Diagnostic methods (such as PE, laboratory testing, imaging, surveys).
	8. (b) Diagnostic challenges (such as access, financial, or cultural).
	8. (c) Diagnostic reasoning including other diagnoses considered.
	8. (d) Prognostic characteristics (such as staging in oncology) where applicable.
Therapeutic Intervention	9. (a) Types of intervention (such as pharmacologic, surgical, preventive, self-care).
	9. (b) Administration of intervention (such as dosage, strength, duration).
	9. (c) Changes in intervention (with rationale).
Follow-up and Outcomes	10. (a) Clinician and patient-assessed outcomes (when appropriate).
	10. (b) Important follow-up diagnostic and other test results.
	10. (c) Intervention adherence and tolerability (How was this assessed?).
	10. (d) Adverse and unanticipated events.
Discussion	11. (a) Discussion of the strengths and limitations in your approach to this case.
	11. (b) Discussion of the relevant medical literature.
	11. (c) The rationale for conclusions (including assessment of possible causes).
	11. (d) The primary "take-away" lessons of this case report.
Patient Perspective	12. When appropriate, the patient should share their perspective on the treatments they received.
Informed Consent	13. Did the patient give informed consent? Please provide if requested.

the posterior part of the PS when performing an IANB. In this technique, the bevel of the needle should be oriented laterally (internal surface of the ramus of the mandible), which increases the possibility of the needle having a medial and posterior deviation when approaching the PR (Fig. 2).

In relation to the possibility of anesthetic injections into the PR, Petersen showed in 1971 that improper application of the IANB technique could cause anesthetic to be deposited in the PR, resulting in an early FP.[36] The steps required to achieve success in the IANB technique are well documented.[27] The essential thing for the dentist is to feel that the needle is in contact with the internal surface of the mandibular ramus, which confirms the PS location, and that the needle is not on the other side. Gay Escoda and Berini Aytés emphasized the importance of this needle–bone contact, specifying that this is the only sure way to prevent injecting the anesthetic into other anatomical areas close to the PS.[37] Thus, the most probable cause of IFP could be explained by the aberrant penetration of the anesthetic solution into the retromandibular space or the fascia of the parotid gland when anesthetizing the inferior alveolar nerve if the needle penetrates beyond the posterior edge of the mandibular ramus.[38–40]

However, the etiology of late FP is not well defined. Several possible factors have been proposed, such as respiratory infection, immunosuppression, stress, fever, menstruation, sun exposure, exposure to cold, dental procedures, and a result of the reactivation of the herpes virus.[21,40,41] Herpes viruses are ubiquitous pathogens that infect humans and other animal species. In the human herpesviridae family, 8 different species are recognized, including herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2), VZV, Epstein–Barr virus (EBV), cytomegalovirus (CMV), human herpesvirus 6 (HHV-6), HHV-7, and HHV-8.[42–46] The reactivation of these viruses cause recurrent infections and trigger cell lysis and multiple symptoms with clinical manifestations.[45–47]

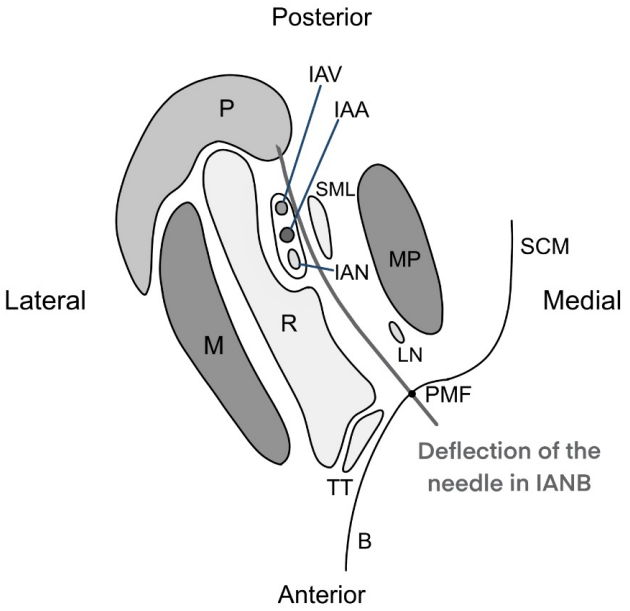

Fig. 2. Schematic representation of needle deflection during IANB in transversal section of the right ramus of mandible (image modified from the article by Khoury et al.[56])

B – buccinator; IAA – inferior alveolar artery; IAN – inferior alveolar nerve; IAV – inferior alveolar vein; LN – lingual nerve; SML – sphenomandibular ligament; M – masseter; MP – medial pterygoid muscle; P – parotid gland; PMF – pterygomandibular fold; R – ramus of mandible; SCM – superior constrictor muscle; TT – tendon temporal muscle; gray line from PMF to P – deflection of the needle in IANB.

The mechanisms related to understanding how viral reactivation triggers FP are not entirely clear, but if anatomical communication is established, this could explain such reactivation to some extent. Herpes simplex virus type 1 is predisposed to a latency period within the neuronal soma of the neurons present in the trigeminal ganglion,[48] which innervates the tongue and gums through the lingual nerve, which in turn is in close contact with the nerve of the tympanic cord (branch of the facial nerve) that carries the parasympathetic innervation to the submandibular and sublingual glands, as well as transmits sensory information from the anterior two-thirds of the tongue.[28] These anatomical and physiological connections allow the local anesthetic injected near the entrance of the mandibular duct during IANB to cause a temperature change due to the vasoconstrictor present in the dental cartridge syringe. This causes the reactivation of the HSV-1 located in the trigeminal ganglion, the VZV located in the facial nerve ganglion or trigeminal ganglion, or the HHV-6 located in the salivary glands in patients infected with these dormant viruses, as it has been shown that these viruses are thermogenic.[49] Gaudin et al. studied 16 patients presenting with FP after a dental intervention, 14 of whom had prodromal symptoms consistent with the manifestation of viral reactivation (lingual tinnitus, dysgeusia, facial numbness, and postauricular pain).[50] Two patients were diagnosed with Ramsay Hunt syndrome (headache, earache and FP). Among the 16 patients analyzed, the IANB technique was used in 8 and was ipsilateral in all patients with FP in relation to the anesthetized side.[50] Furuta et al. studied 8 patients undergoing dental treatment or oral surgery that presented with FP using serological tests and polymerase chain reaction (PCR).[11] The VZV was detected using polymerase chain reaction (PCR) in the saliva of 6 patients and HSV-1 was detected in the saliva of the remaining 2. Similarly, Turriziani et al. evaluated the viral presence in saliva samples from 95 patients who presented with IFP within 48 h of onset, and the following results were observed: HHV-6 was detected in 63% of patients, HSV-1 in 13% and VZV in 3%.[51] There were also animal studies: Fujiwara et al. injected Wistar rats with HSV-1, causing FP in them after 3–5 days.[52]

Finally, the last explanation presented in the literature for FP after ILIA is the activation of sympathetic fibers that surround the stylomastoid artery, causing ischemia in the facial nerve and subsequent FP. Scientific evidence supporting this idea is based on studies on experimental animals that had a vasoconstrictor injected directly into the facial nerve duct, causing FP.[53] Unfortunately, there are no animal studies or clinical trials that analyzed the feasibility of generating this effect through the ILIA.

Only 9 patients received some type of treatment of FP[14,17,18,20,22–25]: 5 were administered corticosteroids,[14,17,18,20,24] 1 was given NSAIDs),[20] 1 received NSAIDs with an antibiotic (amoxicillin) and vitamin B complex,[25] and 1 got vitamin B, cytidine and uridine complexes.[22] (all details are presented in Table 5). The scientific literature reports mainly the administration of corticosteroids, antivirals, or a combination of both. Madhok et al. in their systematic review of corticosteroid treatment for FP found that 17% of patients treated with corticosteroids achieved an incomplete recovery after 6 months of treatment compared to 28% of patients who did not receive treatment.[54] On the other hand, the use of antivirals compared to placebos had a nonsignificant detrimental effect on the recovery from FP. In addition, treatment with the combination of corticosteroids and antivirals showed no benefits compared to treatment with corticosteroids alone.[55] However, these therapies have been described for patients suffering from IFP in which the etiology is not known, different from the scenario identified by dentists, because the patient manifests early or late FP depending on the case. In this regard, the dentist has the advantage of knowing that the etiology of early FP is probably due to the direct condition of the facial nerve caused by anesthesia or due to the effect exerted by the vasoconstrictor on the stylomastoid artery, and they treat this type of FP with the administration of corticosteroids, while it is recommended to treat patients with late FP with a combination of corticosteroids and antivirals due to the possibility of viral reactivation. There are also other means of patient care available, such as the use of artificial tears and eye patches to prevent resection and lesions of the globe and conjunctiva, and the use of artificial saliva to prevent oral dryness and the development of periodontal diseases and caries.

Table 5. Facial paralysis treatment

Study	Facial paralysis treatment
Tiwari and Keane, 1970[14]	5 mg of prednisolone 4 times a day orally, facial muscle exercises, protection of the left eye with dark glasses during the day and a patch at night, mouthwash after meals
Gray, 1978[15]	not reported in all 3 cases
Weinberg et al., 1985[16]	not reported
Ling, 1985[17]	4 mg of triamcinolone 4 times a day orally for 10 days, with gradual dose reduction
Shuaib and Lee, 1990[18]	prednisone, dosage not reported
Miles, 1992[19]	without treatment in both cases
Shenkman et al., 1996[20]	acetylsalicylic acid, dosage not reported
Tazi et al., 2003[21]	prednisone 1 mg/kg for 5 days
Vasconcelos et al., 2006[22]	vitamin B complex and cytidine and uridine complex both twice a day
Tzermpos et al., 2012[24]	20 mg of prednisone 3 times a day during the 1st week, 20 mg 2 times a day during the 2nd week, 20 mg once a day during the 3rd week, and 10 mg once a day during the 4th week and indication of eye lubricant
Ilea et al., 2014[25]	no treatment (kept under observation)
Zhang et al., 2015[26]	without treatment

Limitations

There are some limitations to this study. First, there are few studies reporting FP cases following ILIA, and there may be many undocumented cases, making it difficult to show the true prevalence. Secondly, as far as methodological quality is concerned, no studies attained an excellent level, and there may be a lack of importance for the total understanding of FP following the ILIA.

Conclusions

The FP following ILIA has a low prevalence. Early FP CRs presented the effect of the administered anesthetic on the facial nerve, and the vascular effect of the vasoconstrictor included in the anesthetic formula, while more recent FP CRs focused on the reactivation of HSV-1, HHV-6 or VZV. Furthermore, there seems to be a relationship between the anesthetic technique used and the risk of FP, with special attention paid in this regard to the IANB technique due to the anatomical proximity of the puncture site to the PR and the anatomical space through which the motor branches of the facial nerve pass through to innervate the muscles of facial expression. Close following of the consecutive steps of the IANB technique are essential to prevent FP because contact of the needle with the bone is perceived as the only way to verify that the anesthetic is being deposited in the PS and not in the PR or another anatomical space. However, ensuring the contact of the needle with the bone tissue can prevent the appearance of only early FP, but not late FP. The knowledge about appropriate pharmacological therapy is important in treating late FP. In addition, it seems prudent not to associate IFP or Bell's palsy with FP that occurs after a dental intervention, because unlike the former, there is a possible causative factor of the FP and it is not entirely idiopathic. Furthermore, a scarce but acceptable level of evidence was observed in the present study regarding the relationship between ILIA and FP. Finally, all ILIAs are safe to use in dental practice and must be properly selected depending on the anatomical area to be blocked. However, general dentists and specialists should be updated on the management and treatment of FP after ILIA. Regarding treatment, based on what is described in the literature, we suggest corticosteroids if the FP is early, and a combination of antiviral drugs with corticosteroids in late FP.

Ethics approval and consent to participate

Not applicable.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable

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