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Nerve injury caused by mandibular block analgesia

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Abstract. Fifty-four injection injuries in 52 patients were caused by mandibular block analgesia affecting the lingual nerve ($n = 42$) and/or the inferior alveolar nerve ($n = 12$). All patients were examined with a standardized test of neurosensory functions. The perception of the following stimuli was assessed: feather light touch, pinprick, sharp/dull discrimination, warm, cold, point location, brush stroke direction, 2-point discrimination and pain perception. Gustation was tested for recognition of sweet, salt, sour and bitter.

Mandibular block analgesia causes lingual nerve injury more frequently than inferior alveolar nerve injury. All grades of loss of neurosensory and gustatory functions were found, and a range of persisting neurogenic malfunctions was reported. Subjective complaints and neurosensory function tests indicate that lingual nerve lesions are more incapacitating than inferior alveolar nerve lesions.

Unlike most mechanical injuries after surgery, injection injuries were not followed by a course of spontaneous improvement of neurosensory and/or gustatory function. This may indicate neurotoxicity as a central aetiological factor. Fifty-four percent of the nerve injuries were associated with Articaine 4%, and a substantial increase in the number of injection injuries followed its introduction to the Danish market.

Key words: nerve injury; injection; neurotoxicity; Articaine 4%.

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Mandibular block analgesia is normally a safe and rewarding method of pain control for interventions in dental and oral and maxillofacial surgery practice. Nerve injury caused by injection of local analgesics is considered as rare. Yet, a minor fraction of patients do experience the undesired side effects of a temporary or permanent impairment of neurosensory function after mandibular block analgesia with currently used local analgesics. Estimates indicate a prevalence of temporarily impaired lingual and inferior alveolar nerve function ranging in the order of size of 0.15–0.54%[7,12] whereas permanent injury caused by injection of local analgesics is much less frequent, 0.0001–0.01%[6,7,16] depending on mode of data collection, type of sample, etc. (Table 1).

Subjective symptoms may be manifold and include impaired sensory function such as anaesthesia or hypaesthesia, and neurosensory disturbances of various kinds as paraesthesia, dysaesthesia, etc. Also, the gustatory function may be affected in case of lingual nerve injury[15].

Various views have been expressed to explain the mechanism of nerve injury. Direct physical fascicular damage may be caused by a penetrating injection needle, or by a damaged injection needle on retraction after bone contact[7,12,21]. Intraneural bleeding may exert pressure, and subsequent constrictive scarring may obstruct nerve conduction. Finally, Haas & Lennon[6] suggested that local anaesthetic formulations may have the potential for neurotoxicity, in particular Articaine 4% and Prilocaine 3–4%. Experimentally, neurotoxicity has been demonstrated to induce loss of conductivity and structural changes after intrafascicular microinjec-

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Table 1. Reports on nerve injury caused by inferior alveolar and lingual nerve block analgesia

Author	Temporary injury	Permanent injury	Study design, comment
Krafft & Hickel[12]	<6 months, 0.15%	>12 months, 0.008%	Prospective study, $N = 12.104$ pts. interview
Haas & Lennon[6]	?	0.00013%	Retrospective study, $N > 1.1 \times 10^6$ pts. 'reported cases'
Harn & Durham[7]	0.54%	>12 months, 0.01%	Questionnaire study, $N = 2.735$ pts.; conservative dentistry and oral surgery pts.

tion of local analgesic solutions of concentrations used in current clinical practice[3].

The aims of the present study were to

- Clarify the magnitude of sensory impairment and the character of signs and symptoms in patients suffering sensory dysfunction after mandibular block analgesia.
- Follow and describe the level of function/dysfunction over time.
- Describe possible differences related to type of analgesic agent.

Patients and methods

During the years 1997–2004 the first author (S.H.) examined 56 consecutive patients with injection injury to oral branches of the trigeminal nerve. Patients were referred from all parts of the country of Denmark housing a population of 5.5 million inhabitants. Referrals were obtained from colleagues and the Danish Dental Association's Patient Insurance Scheme covering all dental practitioners.

Criterion for inclusion: Nerve injury caused by unilateral administration of inferior mandibular nerve block for conservative dental procedures (including one simple dental extraction). Inclusion of new patients terminated June 2004.

Criteria for exclusion: Neurological disease, known alcoholism, endodontic procedures that might affect inferior alveolar nerve (IAN) conduction, implant surgery and oral and maxillofacial surgery. Likewise, injury to nerves other than the lingual nerve (LN) and the inferior alveolar nerve (IAN) were excluded ($n = 4$).

Records including date of injury, generic type and volume of local analgesic solution injected and a possible history of sudden painful experience ('electric shock') during injection were obtained by a written questionnaire mailed to the patient, or a by a telephone call to the practitioner who administered the nerve block causing the injury. Since practically all local analgesia in dental practice is dispensed in cartridges containing 1.8 ml, the number of repeat injections could be estimated by knowing the injected volume.

Neurosensory evaluation—interview and clinical examination

All patients were interviewed and examined according to a standardized test of neurosensory functions[10,17,18] by the same observer (S.H.) to clarify the subjective and objective neurosensory status of the injured nerve. A standardized record form was used. The terms applied to neurosensory and gustatory function and dysfunction are listed and explained in Appendix A according to Sunderland[23].

The patients were urged to describe their neurosensory deficit in plain words to be recorded in terms of anaesthesia, hypaesthesia, normaesthesia or hyperaesthesia with reference to the healthy side. The patients rated their sense of subjective sensory perception according to the scores listed and explained in Table 2.

Neurogenic signs and symptoms were recorded as paraesthesia, dysaesthesia, including allodynia[23]. In case of injury to the LN the patients were questioned about their gustatory ability that might be rated as normal, missing (ageusia), deficient (hypogeusia) or distorted (dysgeusia)[4].

The clinical examination included tests of pain perception (blink reflex or protective reaction on pinching with a tissue forceps), 2-point discrimination thresholds and tests of tactile stimuli (feather light touch, pinprick and point dull discrimination), thermal stimuli (0 and 45 °C) and stereotactic stimuli (point location and brush stroke direction)[8,10,17,18]. Patients with injury to the LN were examined for the presence of a traumatic neuroma. An unpleasant, irradiating sensation in the injured side of the tongue induced by digital pressure to the region of suspected injury at the medial aspect of the mandibular ramus was interpreted as caused by a traumatic neuroma.

The sensory function of each stimulus was evaluated with the unaffected side as control and scored according to the ratings listed in Table 2. The sum of 7 semi-quantitative ratings for each patient (feather light touch, pinprick, point/dull discrimination, warm, cold, point location and brush stroke direction, each ranging from 0 to 3) constitutes the 'sum score', thus ranging from 0 to 21[8].

Patients seen less than 12 months after the injury were offered 1 or more re-examinations up till 12 months post injury, at least. Eighteen LN patients and 4 IAN patients accepted follow-up examinations. Nerve injuries causing symptoms beyond 12 months after injury were considered permanent.

Gustatory evaluation

The patients' gustatory function was tested by topical application of sweet (saccharine 5%), salt (sodium chloride 5%),

Table 2. Applied rating scales of neurosensory and gustatory function[8,10]

	Score
Ratings of neurosensory function—pinprick, point/dull discrimination, warm, cold, point location and brush stroke direction	
No perception of stimulus	0
Perception of touch or temperature without ability to discriminate quality of stimulus	1
Perception of quality of stimulus, less clear than healthy side	2
Normal sensory perception of tactile and thermal stimuli	3
The added scores of each function, each ranging from 0 to 3, constitute the **sum score**, range 0–21	
Ratings of gustatory function—sweet, salt, sour and bitter	
No perception of stimulus	0
Perception of test substance but no gustatory input	1
Perception of undefined taste and no recognition	2
Perception with recognition of quality of taste	3
The added scores of each function, each ranging from 0 to 3, constitute the **sum score of gustatory ability (SSGA)**, range 0–12	

sour (citric acid 5%) and bitter (quinine hydrochloride 0.5%) to the injured and the healthy side, respectively, with the healthy side as control. The ratings considered perception of test substance, unspecific taste and a positive recognition of the quality of taste according to Table 2. During the test, the patients were urged to stretch their tongue out of the mouth in order not to involve taste buds other than those on the anterior part of the tongue. A mouth rinse with plain water of room temperature was interposed between each test. The sum of scores of gustatory ability (SSGA) from each test with the 4 substances ranging from 0 to 12 was calculated.

Statistics

Side differences between the healthy and the injured side were tested with Students' *t*-test for paired observations, and χ^2-test was applied for non-parametric testing of frequencies. A 'sign test' was applied to binomial distributions. $P \leq 0.05$ was chosen as level of significance. The software used was SPSS 10.0 for Windows and the EPI6 program packages.

Results

Incidence

Fifty-two patients with unilateral injection injury of the LN ($n = 42$) or/and IAN ($n = 12$) were included in this study. Two patients suffered affection of both the LN and the ipsilateral IAN. Among the 52 patients, females were significantly more frequently stricken ($n = 35$, 67%) than males ($n = 17$, 33%), $P = 0.012$ (Fig. 1). Mean age at time of first examination was 47 years, range 24–81 years. The number of patients referred for consultation per year increased through the period from 1997 through 2004, $P < 0.0002$ (Fig. 1).

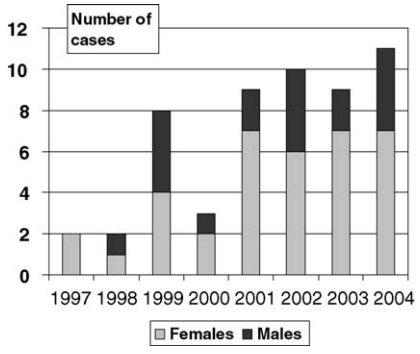

Fig. 1. Distribution of 52 patients referred with 54 injection injuries of inferior alveolar and/or lingual nerves from 1997 to June 2004. Female/male ratio = 2/1, $P = 0.012$.

The LN was more often injured, $n = 42$ (78%) than the IAN, $n = 12$ (23%), $P < 0.0001$, and sidewise 30 patients suffered a right-side, and 22 a left-side injury (n.s.). A total of 17 patients (32%) experienced an 'electric shock' on introduction of the needle, 13 patients (24%) did not. No data were obtained in the remaining 22 patients. There was no difference in neurosensory capacity (sum score) between patients who reported an 'electric shock' and those who did not, $P = 0.74$.

Volume and type of analgesic solution injected

An average volume of 2.6 ml analgesic solution was injected, range 1.4–12 ml. Thirty-three patients received 1 injection of $\leq$1.8 ml, 12 patients received 1 repeat injection of $\leq$1.8 ml, and 5 patients had 2 or more repeat injections. Data on injected volume were missing in 2 patients. No association was found between the injected volume and the severity of nerve injury. Needles of gauge 27 are the typical choice for mandibular block analgesia.

The types (generic name) and concentrations of local analgesic solutions related to injury of the LN and NAI, respectively, are shown in Table 3. Fifty-four percent of the observed cases of sensory impairment were associated with the injection of Articaine 4%. This substance accounts for more injury than any other local analgesic in the present material.

Time course from injury to examination

The average time span from injury to initial neurosensory examination of the 52 patients was 9 months (range 1–37 months). The majority of patients presented with both a neurosensory deficit (hypofunction) and a neurosensory disturbance (malfunction). The results of the initial examination are presented in detail in Tables 4–6.

The patients' subjective experience of change of sensory capacity during the time course from injury to initial examination reflected no systematic pattern of variation for either nerve.

Lingual nerve, status, change with time, permanent disability

Forty-two patients, 25 females (60%) and 17 males (40%) presented with an injection injury of the LN. The average delay in presentation was 8 months (range 1–32 months). An experience of sudden painful 'electric shock' on injection was experienced by 14 patients (33%), 10 patients (24%) had no such experience and in 18 cases (43%) no data were available to quantify this feature.

The patients' own and subjective rating of sensory capacity was that of severe impairment in 63% (less than score 2) as compared to the uninjured side, mean score was 1.5 (range 0–3), $P < 0.0001$. The patients described their sensory incapacity in terms of hyperaesthesia ($n = 1$), normaesthesia ($n = 3$), hypaesthesia ($n = 33$), anaesthesia ($n = 3$) and other ($n = 2$).

Neurogenic complaints included paraesthesia ($n = 18$), dysaesthesia ($n = 9$), allodynia ($n = 3$), none ($n = 3$) and no information/other ($n = 9$), paraesthesia being the most prevalent complaint. A painful burning sensation of varying intensity was felt by 9 patients (21%). Nine patients (23%) showed clinical signs of a neuroma. The pattern of neurogenic complaints and sensory ratings of these 9 patients did not differ significantly from that of the remaining patients, $P = 0.66$.

Painful stimuli were perceived by 36 out of 40 patients (90%, no data in 2 patients) in the injured side of the tongue versus the healthy side (n.s.). Six patients (14%) were not able to discriminate 2 points with a distance of 20 mm or less. Mean 2-point discrimination threshold for the remaining 36 patients was higher in the injured side, 8.6 mm versus 6.7 mm in the healthy side, $P = 0.003$.

Neurosensory test with rating of perception of tactile, thermal and location stimuli showed a significantly reduced sensory

Table 3. Distribution of analgesic solution and nerve affected including 54 nerve injuries in 52 patients

	Inferior alveolar nerve	Lingual nerve	Sum *N* (%)
Articaine 4%	5	24	29 (54%)
Prilocaine 3%	4	6	10 (19%)
Lidocaine 2%	3	7	10 (19%)
Mepivacaine 3%	0	4	4 (7%)
Mepivacaine 3% + Articaine 4%	0	1	1 (2%)
Number of nerve injuries	12	42	54 (100%)

Table 4. Sensory function of the lingual nerve after injection injury, initial examination ($n = 42$)

	Score value, mean (SD), injured side	Difference from healthy side
Patients' subjective rating	1.5 (0.8)	***
Feather light touch	1.6 (1.1)	***
Pinprick	2.0 (0.9)	***
Sharp/dull differentiation	1.9 (1.0)	***
Warm (45 °C)	2.2 (1.1)	***
Cold (0–20 °C)	2.3 (0.8)	***
Localization	2.3 (1.1)	***
Brush stroke direction	2.4 (1.1)	***
Sum score	14.2 (5.8)	
Pain perception ($n = 40$)	36/40 (90%)	
Two-point discrimination threshold ($n = 42$)	>20 mm, $n = 6$ (14%) <20 mm, $n = 36$ (86%) Mean 8.6 (4.6)	**
Neuroma ($n = 30$)	9 (30%)	

Levels of significance: $^{n.s.}P > 0.05$; $^{*}P < 0.05$.
$^{**}P < 0.01$.
$^{***}P < 0.001$.

Table 5. Gustatory perception after injection injury

	Initial examination		Final examination	
Taste	Injured side	Healthy side	Injured side	Healthy side
Sweet, saccharine 5%	4 (22%)	10 (56%)	4 (22%)	5 (28%)
Salt, sodium chloride 5%	4 (22%)	10 (56%)	3 (17%)	12 (67%)
Sour, citric acid 5%	4 (22%)	12 (67%)	7 (39%)	13 (72%)
Bitter, chinine hydrochloride 0.5%	4 (22%)	9 (5%)	5 (28%)	14 (78%)

Patients' ability to recognize the taste of sweet, salt sour and bitter. Paired observations ($n = 18$).

capacity of all tested functions in the injured side (Table 4).

Eighteen patients were re-examined on average 13 months after the injury (range 9–19 months). Five patients experienced an improved LN sensory function, 2 felt no difference, another 2 reported a deterioration of function, and no subjective data were obtained in the remaining 9 patients. The paired observations of neurosensory examination in 18 patients showed no significant change over time with a sum score of 14.6 (SD 6.2) at the final examination versus sum score of 14.8 (SD 7.0) found at the initial examination (n.s.). This unexpected feature is shown graphically in Figs 2–4. Different formulations of local analgesics exhibited fairly comparable patterns of neurosensory impairment and a similar lack of improvement with time (Fig. 4).

Table 6. Sensory function of the inferior alveolar nerve after injection injury, initial examination ($n = 12$)

	Score value, mean (SD) injured side	Difference from healthy side
Patients' subjective rating	1.8 (1.09)	**
Feather light touch	2.5 (0.50)	**
Pinprick	2.3 (0.62)	*
Sharp/dull differentiation	2.4 (0.88)	
Warm (45 °C)	2.4 (1.15)	n.s.
Cold (0–20 °C)	2.4 (1.03)	n.s.
Localization	2.8 (0.62)	n.s.
Brush stroke direction	2.8 (0.87)	n.s.
Sum score	17.3 (0.56)	*
Pain perception ($n = 11$)	10 (90%)	
Two-point discrimination threshold ($n = 11$)	>20 mm, $n = 2$ (18%) <20 mm, $n = 9$ (82%) Mean = 9.1 mm (n.s.)	

Levels of significance: $^{n.s.}P > 0.05$; $^{***}P < 0.001$.
$^{*}P < 0.05$.
$^{**}P < 0.01$.

Taste

In 33 patients (79%) the gustatory perception of the injured side was damaged. In the remaining 9 patients (21%) no side difference was found. When comparing SSGA scores of all LN patients ($n = 42$), a significantly reduced gustatory function of the injured side versus the healthy side at both initial ($P < 0.0001$) and final examination ($P < 0.001$) was found. Paired observations in 18 patients showed no improvement of gustatory function over time ($P = 0.881$) (Table 5). Dysgeusia in the form of persistent unpleasant taste of metal was reported by 4 patients and 6 patients had trouble with the taste of salt either as a constant nuisance or as inability to dose salt correctly when cooking.

Inferior alveolar nerve, status, change with time, permanent disability

Twelve patients presented with injection injury to the IAN, 11 females and 1 male. Altered sensory function was reported as anaesthesia ($n = 2$), hypaesthesia ($n = 6$), hyperaesthesia ($n = 1$) and normal sensory function + unpleasant neurogenic sensation ($n = 3$).

Unpleasant (neurogenic) sensations included paraesthesia ($n = 8$), dysaesthesia ($n = 2$) and neuralgic pain ($n = 1$), and data were missing in 1 patient. The patients with IAN lesions presented at the initial neurosensory examination with a median time course of 15 months (range 5–37 months) after the injection injury. Due to this reason only 4 patients were followed over time. None of these showed major changes of sensory function, and hence most neurosensory disturbances could be considered as permanent.

Three IAN patients reported the experience of a painful 'electric shock' on injection. Another 3 patients had no such experience, and in 6 patients we have no data regarding sudden pain on injection.

Patients' subjective rating of sensory function averaged 1.8 (range 0–3) representing a significant reduction as compared with the healthy side, $P = 0.006$. One patient (9%) did not respond to painful stimuli to the injured side of the lower lip.

Two patients (18%) were not able to discriminate 2 points with a distance >20 mm in the injured side. Mean 2-point discrimination threshold value of the

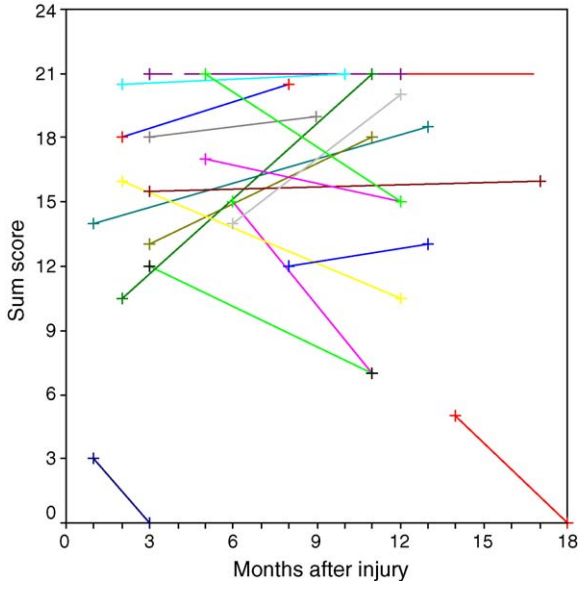

Fig. 2. Sum scores at initial and final examination of 18 patients with lingual nerve injection injury. No systematic trend in change of neurosensory function of injured lingual nerve over time.

remaining IAN patients showed no side difference, 9.2 mm (SD 3.1 mm) versus 9.1 mm (SD 1.8 mm) in the healthy side.

On objective testing, the tactile senses of feather light touch, pinprick and sharp/dull differentiation were most severely affected. Sum score and scores of specific functions are listed in Table 6. The sensory capacity expressed as the sum score showed a significant reduction of the injured side as compared to the unaffected side, $P = 0.02$.

Four patients were re-examined after an average of 8 months after the initial examination. They showed no consistent pattern of change of IAN neurosensory function with time.

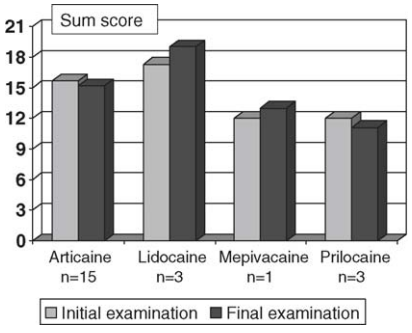

Fig. 3. Sensory function of lingual nerve and inferior alveolar nerve after injection injury at initial and final examinations related to generic type of analgesic solution. No significant difference of severity and pattern of change over time. Average 8 months of follow-up (2–13). Paired observations, $n = 22$.

Discussion

Incidence and report of cases: The present study indicates an increased incidence of reported injection injuries in dental practice over time. Several factors may account for that. There is a global trend for patients to complain of disappointing treatment outcomes, side effects and complications to dental and medical treatment. Quality of care is in focus, and patients' expectations are calibrated on a high level of knowledge. Like in Ontario, Canada[6], an increase in the number of patients with injection injuries was observed after the introduction of Articaine 4%.

In the past, injection injuries have attained only little attention, and still such

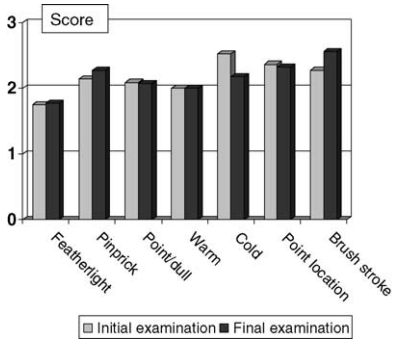

Fig. 4. Sensory function of the lingual and inferior alveolar nerves after injection injury at initial and final examinations. No significant changes were detected. Average 8 months of follow-up (2–13). Paired observations, $n = 22$.

an injury is rare. The incidence of transient neurosensory changes caused by injection is unknown. However, those patients who suffer a long-standing injection injury are frequently incapacitated for the rest of their lives. This is a good reason to deal with the problem of injection injury. To the authors' knowledge no previous longitudinal study on injection injury with repeated neurosensory examinations has been published. This was possible in the present study owing to several factors:

1. A centralized pattern of referrals mainly to our unit for neurosensory evaluation provided the influx of patients from the entire country of Denmark with its 5.5 million population.
2. The limited size of the country rendered follow-up examinations feasible.
3. Local analgesia injection injury is considered a 'no culpa' incident, i.e. insurance coverage is not conditioned by proven malpractice.
4. Thus, the practitioner is placed in a solicitor's role rather than as an object of litigation, and there is no incentive not to report cases.

Gender: Females are more often affected by injection injury than males. This feature is probably reflecting a more general trend in the distribution of nerve injuries. A female predominance was described in several other nerve injury studies, such as nerve injury related to injection[16], third molar surgery[24], lingual nerve repair[8], injury caused by dental treatment[5] and traumatic injuries[19]. Assuming that mandibular block analgesia is given in equal numbers to females and males, the present female/male ratio being 67%/33% may indicate a greater vulnerability on the part of the female gender.

Nerves at risk: Two nerves are at risk in relation to mandibular block analgesia, the LN and the IAN. For unknown reasons and in accord with a similar study by Pogrel & Thamby[16] the LN is affected significantly more frequently than the IAN. Judging by the patients' sensory impairment, their neurogenic complaints and the neurosensory examination, LN injury seems in general more severe and disturbing than IAN injury.

Needle trauma—aetiology?: It has been claimed that needle contact with a nerve felt by the patient as an 'electric shock' is related to injection injury[7]. Krafft & Hickel[12] reported an incidence of 'electric shock' of 7% in a prospective study in the search for injection injuries, and it was argued that 'electric shock' is not an aetiological factor since no patients in this

group suffered a nerve injury, temporary or permanent. The experience of an 'electric shock' in 17 LN patients (40.5%) was much more frequent in the present study on patients with actual nerve injury as compared to the study of KRAFFT & HICKEL[12]. Nevertheless, we found no difference in the severity of nerve injury with or without the experience of an 'electric shock'. This indicates that 'electric shock' *per se* is probably of minor relevance for the aetiology of injection injuries. Neither did the injected volume nor repeat injections associate with the severity of nerve injury. It is unknown whether it takes an intrafascicular injection to produce an injection injury or whether injection in close relation to a nerve may cause neurotoxic damage. Conversely, it is known from animal studies than intrafascicular injection can produce such an injury[3].

Complaints and objective findings: The trigeminal nerve relates to approximately 30% of the sensory cerebral cortex, and it appears understandable that lesions of major branches of the trigeminal nerve may play a dominant role for the compromised well-being of nerve injury patients. It is evident from patients' complaints, ratings of sensory capacity and sum scores that LN injuries are much more incapacitating than IAN lesions. The sensory improvement during a spontaneous healing course known from physical lesions of the IAN or LN associated with third molar surgery[9] and orthognathic surgery[25] is virtually absent. This feature is reflected in the lack of improvement and insignificant changes in all neurosensory qualities tested. These results may, therefore, indicate neurotoxicity with irreparable damage to tissue function as a major aetiological factor as shown experimentally by CORNELIUS et al.[3].

Gustation: As demonstrated, the test for gustatory perception is characterized by a fairly low sensitivity, especially so for the perception of sweet, judging by the uniformly underscored ratings from the healthy side. Also, a considerable biologically and genetically determined variation of gustatory perception must be accepted[1,2]. Still, injection injuries unmistakably seem to hamper the perception of gustatory input of all the 4 test substances, and unlike some improvements observed after physical injuries or lingual nerve repair[8,9,20], no improvement in gustatory function over time was seen in the present study.

Type and concentration of analgesic solution: Injection injuries may be associated with all local analgesics in clinical use. A number of clinical studies have focused on adverse events and tissue reaction to Articaine 4%[11,13,14], and harmful effects have not been demonstrated, in particular not any nerve injury. KRAFFT & HICKEL[12] found in a prospective study on 12,104 patients only one single case with permanent nerve injury. Since the incidence of injection injury as such is extremely rare, the finding of nerve injury in a clinical trial is comparable with the finding of a needle in a haystack. This feature imposes a methodological obstacle to the power of conclusion from prospective clinical studies on injection injuries[14], and circumstantial evidence, experimental research and retrospective surveys on great number of patients must be taken into account.

HAAS & LENNON[6] investigated the number of reported cases of injection injury (paraesthesia) in Ontario, Canada, over a 20-year period from 1973 to 1993, and noted an abrupt increase in the frequency in 1985, the year after Articaine 4% was available. Their observations that permanent nerve injuries were found mainly after injection of Articaine 4% and Prilocaine 4% found support in an experimental study in an animal model[3]. CORNELIUS et al.[3] found a 90% rate of extinction of sensory evoked potentials (SEV) response after microinjection of Articaine 4% in the sciatic nerve of rats versus SEV extinction in only 10% produced by 2% concentrations of both Articaine and Xylocaine indicating a decisive role of the concentration of analgesic solution. Histopathological examination of nerve specimens of the same study showed that Articaine 4% produced tissue damage comparable to SUNDERLAND class 4 lesions[22].

The present study shows that nerve injuries caused by Articaine 4% cover more than half of our sample in spite of the fact that it was introduced only in the middle of the 8-year data collection period. The increased incidence of injection injury follows the introduction of Articaine 4% to the Danish market in December 2000, similar to the abrupt increase in incidence of injection injuries reported from Ontario, Canada, after the introduction of Articaine 4% in 1984[6]. Data from the years 2001 and 2002 collected by the Danish Dental Association's Patient Insurance Scheme covering all dental practitioners in Denmark show a market share of Articaine 4% of 13.4 millions DKr that gave rise to 14 reported injection injuries, whereas Lidocaine 2%, Prilocaine 3% and Mepivacaine 2 and 3% totalling a market share of 22.7 millions of DKr produced only 1 injection injury. This indicates that during the 2-year period mentioned, Articaine produced a more than 20-fold higher incidence of injection injury when applied for mandibular block analgesia.

Despite the lack of precise data, we have no reason to believe that the use of mandibular block analgesia has increased substantially in number over the last 10 years, and therefore, the association of an increased incidence of injection injuries with the introduction of Articaine 4% also in Denmark is remarkable.

Thus, there is an urgent need for further studies focused on the problem of neurotoxicity of local analgesics with specific focus on Articaine 4%. Until factual information is available, a preference of other formulations to Articaine 4% may be justified, especially for mandibular block analgesia.

Appendix A. Applied neurological terms in alphabetic order

Ageusia: absence of gustatory perception
Allodynia: pain due to a stimulus that is not normally painful when applied elsewhere to the body
Anaesthesia: insensitivity to all forms of stimulation
Analgesia: absence of pain in response to stimulation that should normally be painful
Dysgeusia: distorted gustatory perception
Dysaesthesia: any unpleasant abnormal sensation, either spontaneous or evoked, here used to describe painful paraesthesia and burning neurogenic discomfort and pain
Hypaesthesia: diminished sensitivity to all forms of stimulation
Hyperaesthesia: increased sensitivity to all forms of stimulation
Hypogeusia: decreased gustatory perception
Paraesthesia: unusual, abnormal but not painful, spontaneous or evoked sensations (tingling or pricking sensation)

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