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ORIGINAL ARTICLE

Prevalence of iatrogenic trigeminal nerve injuries in routine dental practice in private, public, and educational clinics of Riyadh, Saudi Arabia

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ABSTRACT

Background: The trigeminal nerve (V) is a critical nerve in the maxillofacial region relevant to dentistry. The nerve trifurcates into ophthalmic, maxillary, and mandibular nerves . The risk of having trigeminal nerve injuries (TNIs) is relatively high as dentists from various specialties perform trigeminal nerve blocks in routine dental practice. The causes of TNIs can be varied and broadly classified into iatrogenic and non-iatrogenic. The current study aimed to assess the prevalence of TNIs, mainly iatrogenic injuries, in Riyadh, Saudi Arabia, and examine the various dental factors associated with these types of nerve injuries.

Methods: A cross-sectional study was carried out through a questionnaire. The questionnaire consisted of two major parts: demographic data and injury assessment and management. The participants were 349 in number and were dentists, interns, and dental students working in private, governmental, and educational sectors. The participants were approached by a simple random sampling technique. The reporting of the iatrogenic cases is mainly outlined.

Results: Among the participants, 45.9% were dentists, 35.8% students, and 18.3% were interns. Most cases (93%, *N* = 44) were presented with neuropathy due to iatrogenic injury. Out of the 93% reported cases, 65.9% were related to extractions, 27.3% were associated with implants and restorative procedures, and 18.2% were related to endodontic procedures. Temporary injuries accounted for 82%, whereas permanent injuries were 18%. The inferior alveolar nerve is affected more often than the lingual nerve. Most of these injuries (70%) were referred to oral and maxillofacial surgeons for follow-up.

Conclusion: An appropriate assessment, thorough history, and clinical examination would significantly help prevent TNI cases. Moreover, well documentation and prompt reporting and referral by the clinicians would ensure optimum patient care. Therefore, further studies covering the main Saudi regions other than Riyadh city are advocated to establish preventive and management protocols.

Keywords: Trigeminal nerve, iatrogenic, injuries, dental.

Introduction

The trigeminal nerve is the major nerve in the maxillofacial region that is related to dentistry [1]. The trigeminal nerve (V) has the most complex anatomic course of the 12 cranial nerves as it trifurcates into ophthalmic, maxillary, and mandibular nerves [2]. Since dentists from various specialties give trigeminal nerve blocks in routine dental practice, the risk of having trigeminal nerve injuries (TNIs) is relatively high. Hence, TNIs remains a topic of common interest for research purposes.

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The exact prevalence of TNI remains unclear due to the lack of unified and well-established diagnostic criteria for TNIs [3]. The causes of TNIs can be broadly classified into iatrogenic and non-iatrogenic. Iatrogenic causes of dental origin that can lead to TNIs include a wrong technique of local anesthesia injections, extrusion of the root canal materials beyond the apex, tooth extraction, or implant placement without proper radiographical assessment [4-6].

The incidence of traumatic cranial nerve injury is estimated to be 5%-23% [7]. Renton et al. [8] reported that the number of patients presented with inferior alveolar nerve (IAN) injury is slightly more than those presented with lingual nerve (LN) injury. Yilmaz et al. [3] reported the incidence of TNIs to be 89.5% due to iatrogenic reasons and 10.5% due to non-iatrogenic causes. Such injuries can range from minor to catastrophic neuropathic events [9]. Another study by Kim et al. [10] declared that most TNIs were objective symptoms rather than subjective symptoms and reported the IAN followed by the LN as the most commonly affected nerve branches.

Adverse events can be mainly categorized into systemic and local manifestations. The systemic manifestations include toxicity and hypersensitivity reactions, whereas local manifestations involve pain, neuropathy, hematoma, soft tissue injury, infection, and mucosal lesion [9]. According to Devine et al. [11] most common findings were neuropathic pain (n = 24, 86%), followed by anesthesia (n = 15, 54%), dysesthesia (n = 12, 43%), paraesthesia (n = 11, 39%), allodynia (n = 10, 36%), hypoesthesia (n = 9, 32%), hyperalgesia (n = 8, 29%), hyperesthesia (n = 5, 18%), and hyperpathia (n = 2, 7%). A study by Renton et al. [8] declares that 88% of patients with IAN injuries were complaining of constant pain and altered sensation. However, only 44% of patients with LN injuries developed these symptoms.

Consequently, patients suffering from such damage report considerable reductions in their quality of life and may have associated psychological problems [2]. When it comes to the needle size, McPherson et al. [12] concluded that there was no difference between larger-bore 27-gauge and standard-bore 27-gauge needle in pain perception. Renton et al. [13] reported articaine as the most frequently used local anesthetic solution. Moreover, inaccurate radiological identification of the IAN/mental nerve and their anatomical variations were identified to be the most frequent cause of IAN injuries. According to Jerjes W et al. [14], age was an essential risk factor for developing permanent IAN injuries as most of the reported cases were 25 years old and above .

Klazen et al. [1] stated that most TNIs were caused by third molar surgery and local anesthesia. Moreover, most of the injuries were permanent as patients had the symptoms for more than 6 months . According to Renton et al. [8], 87.5% of LN injuries were permanent compared to 60% of IAN injuries.

A literature review by Renton et al. [15] concluded that reassurance and counseling were adequate management for 51% of IAN injuries and 55% of LN injuries. However, the prevalence and incidence of these events are unknown; hence they are often underestimated. Thus, evaluation of the prevalence and reasons associated with TNIs is clinically significant. In Saudi Arabia, there are no studies related to the events of TNIs; therefore, the incidence and prevalence of TNIs remain unknown. Hence, the present study aimed to assess the prevalence of TNIs in Riyadh, Saudi Arabia, and determine the factors associated with these injuries.

Subjects and Method

A cross-sectional observational analysis was conducted to investigate the prevalence of iatrogenic TNIs associated with a routine dental practice in Riyadh, Saudi Arabia. A modified pre-approved questionnaire was used as a primary assessment tool for the data collection since it was the most applicable method to approach the participants in Riyadh. The participants were dental practitioners, including dentists, interns, and dental students. A random sampling technique was used to approach the subjects. The sample size was calculated based on a 95% confidence level, 5% confidence interval, and 50% estimated population response distribution. This sample size was calculated using https://www.calculator.net/sample-size-calculator.html. The sample size resulted from this calculation was 350 participants.

The questionnaire was divided into two parts: the first part was related to the demographic data of the subjects, and the second part was about the iatrogenic injury assessment and management. The demographic data variables included practice level with a further specification for student's year, the specialty of the participant, and their clinical experience. Moreover, the work-related information was used to assess their type of engagement in terms of where they are working (public, private, teaching clinics) and how many patients they treat per week. Data related to injury assessment and management were also assessed, including types of pre-clinical assessment tools used by the clinician (e.g., clinical examination, type of radiographs, and patient's history). The age group of the patients who have had injuries was also enquired along with assessing the patient's systemic health as some diseases could alter the response to local anesthesia. Another question was added to exclude cases that happened due to non-dental treatment.

On the contrary, injuries caused by dental treatments like restorative treatment, extraction of teeth, implant placement, or endodontic procedure were examined carefully. Additionally, a question was added to determine the type of local anesthesia and the size of the needle used during the treatment. Assessment of the patient's response during the faulty injection was also determined. Clinicians' follow-up data regarding their knowledge about the nature of injury (permanent, temporary) and

the particular nerve branch affected were also collected, including any referrals or follow-ups if carried out. Data collection was carried out using online, paper-based surveys. Data entry, cleaning, and analysis were done manually through the Statistical Package for the Social Sciences (SPSS) version 22. The chi-square test was used as a test of significance to compare categorical data (e.g., the participants' specialty along with the number of iatrogenic injury cases). *T*-test and analysis of variance tests were used to evaluate the significance of compared numerical data. Logistic regression analysis was performed to determine the significant predictors with all possible confounders, such as sex (1 = female, 2 = male), sector (1 = governmental, 2 = private, 3 = educational), and other variables. The choice of the variables in the model was based on the results of univariate analysis, and the significant variables in the univariate analyses were subsequently used in the logistic regression analysis. For all statistical analyses, a *p*-value of <0.05 is considered to be significant.

Results

Among the study subjects, 45.9% were dentists ($n = 160$), 35.8% students ($n = 125$) and 18.3% were interns ($n = 64$). Most of them were general practitioners (79.4%, $n = 277$), and the remaining were from Endodontic, Restorative, Periodontics, Prosthodontics, Oral and Maxillofacial (OMF), Pedodontics, and Orthodontics Departments. About two-thirds of the study subjects (65.9%, $n = 230$) were having experience of 1-5 years, and the majority of them (83.1%, $n = 290$) were having full-time dental practice. Regarding the types of practice, 25.2% were practicing in public clinics ($n = 88$), 30.9% in private clinics ($n = 108$), and 43.8% in teaching clinics ($n = 153$). About half of the participants (51%, $n = 178$) treated 5-10 patients per week (Table 1).

Table 1. *Basic characteristics of study subjects (n = 349).*

Characteristics	No. (%)
Level of study subjects	
Student	125 (35.8%)
Intern	64 (18.3%)
Dentists	160 (45.9%)
If student, which year	
Third year	21
Fourth year	34
Fifth year	70
Type of specialty	
General Practitioner	277 (79.4%)
Endodontic	7 (2%)
Restorative	17 (4.9%)
Periodontics	11 (3.2%)
Prosthodontic	12 (3.4%)
OMF	9 (2.6%)
Pedodontics	7 (2.0%)
Orthodontics	9 (2.6%)
Years of experience	
1-5 years	230 (65.9%)
6-10 years	76 (21.8%)
11 years and more	43 (12.3%)
Type of practice	
Full time	290 (83.1%)
Part time	59 (16.9%)
Type of practice	
Public clinic	88 (25.2%)
Private clinic	108 (30.9%)
Teaching clinic	153 (43.8%)
No. of patients treated per week	
5-10 patients	178 (51%)
11-20 patients	81 (23.2%)
21-30 patients	44 (121.6%)
31 and more	46 (13.2%)

Most of the study subjects responded positively toward the occurrence of nerve injuries where 87.4% ($n = 305$) experienced no injuries in their practice, while 44 of the participants experienced them; 10.3% of the subjects had 1-5 nerve injuries, and only 2.2% had more than 5 nerve injuries. About 46.5% of the injured patients were 18-35 years old, and 34.9% were 36-55 years old. Regarding the distribution of injuries based on specialty, 27.3% ($n = 12$) of the participants noticed injuries related to restorative procedures, 65.9% ($n = 29$) reported injuries related to extractions, 27.3% ($n = 12$) reported injuries related to implant treatment and18.2% ($n = 8$) responded that injuries were due to Endodontic procedures (Table 2).

The management of nerve injuries was studied by investigating the related clinical variables. The study subjects were asked about the pre-clinical assessment tools they used. The multiple responses provided by the study subjects included history (80.5%, $n = 268$), clinical examination (92.2%, $n = 307$), and radiography (87.7%, $n = 292$). The type of radiograph predominantly used was the orthopantomogram (OPG) radiograph. In most of the injury cases, 77.8% ($n = 28$) used 27G needle, and 33 out of 44 (75%) participants used lignocaine as the type of anesthetic solution. Only 10 participants had expressed that nerve injuries were related to anesthesia. About 39.5% (17 out of 43) had observed unusual pain during the injection. The type of nerve injury, either permanent or temporary, was reported by 8 out of 44 (18.2%) and 33 out of 42 (78.6%) participants, respectively. Most of the injuries were followed up later. About 66% of the participants reported three or more follow-ups. Most of the subjects (38 out of 44), who had come across the nerve injuries during treatment, referred their patient to an oral maxillofacial surgeon, neurological department, oral medicine, and others. Most of the participants noticed

Table 2. *Distribution of variables related to nerve injury*

Study variables	No. (%)
No. of nerve injuries (*n* = 349)	
0	305 (87.4%)
1-5	36 (10.3%)
6-10	4 (1.1%)
>10	4 (1.1%)
Age group of injured patients (*n* = 43)	
18-35	20 (46.5%)
36-55	15 (34.9%)
>55	1 (2.3%)
All age groups	7 (16.3%)
Had systemic diseases (n = 44)	
Yes	14 (31.8%)
No	30 (68.2%)
Injuries due to non-dental treatment (*n* = 43)	
Yes	3 (7%)
No	40 (93%)
Injuries related to restorative procedures (*n* = 44)	
Yes	12 (27.3%)
No	32 (72.7%)
Injuries related to extraction of wisdom tooth (*n* = 44)	
Yes	29 (65.9%)
No	15 (34.1%)
Injuries related to implant treatment (*n* = 44)	
Yes	12 (27.3%)
No	32 (72.7%)
Injuries related to Endodontic procedures (*n* = 44)	
Yes	8 (18.2%)
No	36 (81.8%)
Procedure related to nerve injuries not mentioned (*n* = 50)	
Yes	21 (42%)
No	29 (58%)

the mandibular nerve (33 out of 41) to be more affected by the injury than the maxillary branch. Furthermore, the IAN subdivision reportedly being more affected by the injury. Regarding injury assessment, 19 out of 44 participants reported that the injury was mainly due to complex anatomy (Table 3).

Regarding the type of specialty, the distribution number of nerve injuries indicates that 25 out of 277 general practitioners (GP) had observed nerve injures (22 GP encountered 1-5 injury cases & 3 GP encountered more than 5 injury cases). The remaining 19 out of 72 participants from other dental specialties had also observed nerve injures (14 specialists encountered 1-5 injury cases & 5 specialists encountered more than 5 injury cases). About 21 out of 44 participants with 1-5 years of working experience had observed nerve injures, whereas the remaining 23 participants with more than 5

Table 3. *Distribution of variables related to nerve injuries and their management.*

Study variables	No. (%)
Pre-clinical assessment-tools used (multiple responses)	
History	268 (80.5%)
Clinical examination	307 (92.2%)
Radiographic	292 (87.7%)
Type of radiographs (multiple response)	
PA radiograph	144 (54.5%)
CBCT	87 (33%)
Bitewing	128 (48.5%)
OPG radiograph	211 (79.9%)
Type of needle used (*n* = 36)	
27 G	28 (77.8%)
25 G	2 (5.5%)
30 G	3 (8.3%)
	3 (8.3%)
Type of anesthesia sued (*n* = 44)	
Lignocaine	33 (75%)
Articaine	2 (4.5%)
Mepviocaine	4 (9%)
Prilocaine	2 (4.5%)
All types	3 (6.8%)
Injury related to anesthesia (*n* = 43)-Yes/No	10 (23.2%)/33 (76.8%)
During injection, unusual pain reported (*n* = 43)-Yes/No	17 (39.5%)/26 (60.5%)
Nerve injuries permanent (*n* = 44)-Yes/No	8 (18.2%)/36 (81.8%)
Nerve injuries temporary (*n* = 42)-Yes/No	33 (78.6%)/9 (21.4%)
Injury followed up later (*n* = 45)-Yes/No	40 (88.9%)/5 (11.1%)
No. of follow ups (*n* = 41)	
Once	6 (14.6%)
Twice	8 (19.5%)
Three times	10 (24.4%)
>Three times	17 (41.5%)
Name of affected nerve branch(n=41)	
Ophthalmic nerve	2 (4.9%)
Maxillary nerve	5 (12.2%)
Mandibular nerve	33 (80.5%)
More than one	1 (2.4%)
If, Mandibular nerve affected, which branch? (*n* = 36)	
IAN	28 (77.8%)
LN	6 (16.7%)
All	2 (5.5%)
If LA injury, related to difficult anatomy (*n* = 39)-Yes/No	19 (48.7%)/20 (51.3%)
Reported the injury (*n* = 40)-Yes/No	31 (77.5%)/9 (22.5%)
Patient referred to whom (*n* = 38)	
Oral Maxillofacial surgeon	26 (68.4%)
Neurological department	7 (18.4%)
Oral Medicine	2 (5.3%)
Others	3 (7.9%)

Table 4. *Distribution of study variables in relation to the number of injuries.*

Study variables	No. of nerve injuries			
	0	1-5	6-10	>10
Type of specialty				
General Practitioner	252 (91)	22 (7.9)	1 (0.4)	2 (0.7)
Endodontic	5 (71.4)	2 (28.6)	0	0
Restorative	13 (76.5)	3 (17.6)	1 (5.9)	0
Periodontics	8 (72.7)	3 (27.3)	0	0
Prosthodontic	9 (75)	1 (8.3)	2 (16.7)	0
OMF	4 (44.4)	3 (33.3)	0	2 (22.2)
Pedodontics	7 (100)	0	0	0
Orthodontics	7 (77.8)	2 (22.2)	0	0
Years of experience				
1-5 years	209 (90.9)	20 (8.7)	1 (0.4)	0
6-10 years	65 (85.5)	9 (11.8)	1 (1.3)	1 (1.3)
11 and more	31 (72.1)	7 (16.3)	2 (4.7)	3 (7)
Type of practice				
Full time	253 (87.2)	30 (10.3)	3 (1.0)	4 (1.4)
Part time	52 (88.1)	6 (10.2)	1 (1.7)	0
Type of practice				
Public clinic	67 (76.1)	18 (20.5)	2 (2.3)	1 (1.1)
Private clinic	94 (87)	12 (11.1)	1 (0.9)	1 (0.9)
Teaching clinic	144 (94.1)	6 (3.9)	1 (0.7)	2 (1.3)

years of working experience had observed nerve injuries in the range of 1-5, 6-10, and >10 injuries. Regarding the injuries reported by participants in their full-time practice (37 out of 44), 30 participants reported injuries in the range of 1-5, 3 in the range of 6-10, and 4 participants reported more than 10 nerve injuries. Furthermore, participants practicing in public clinics (n = 18) had reported nerve injuries in the range of 1-5, whereas three participants encountered more than five injury cases. Regarding the injuries reported by participants in private clinics, 12 participants reported nerve injuries in the range of 1-5, whereas 2 participants reported more than five cases of nerve injuries. Moreover, regarding practitioners with teaching clinical experience, six participants reported nerve injuries in the range of 1-5, and three participants reported more than five injuries (Table 4).

Discussion

The current study provides an estimate of the number and incidence of TNIs in dentistry by students (n = 125), interns (n = 64), and dentists (n = 160). Renton et al. [3] found that the prevalence of TNIs with local anesthesia administration in the UK was 445, which is critical compared to our results. Other factors related to the preventive measures carried out to avoid TNIs, including proper history taking, thorough clinical examination, and diagnostic radiographs, were considered. Moreover, the willingness to report these injuries through closed-ended questions was also included in the distributed questionnaire.

A cross-sectional study was carried out through a pre-approved, modified questionnaire to fulfill the primary and some of the secondary aims of the study. The participants were dentists, interns, and dental students. A random sampling technique was used to approach the subjects. The sample size was calculated based on a 95% confidence level, 5% confidence interval, and 50% estimated population response distribution. The sample size resulted using this calculation is 350 participants, and the data was further analyzed using the SPSS.

On the contrary, Carter et al. [4] utilized access to retrospective reported cases from 1999 to 2008 of non-surgical paraesthesia as the primary tool in their paper. Considering what was already stated in the results section, the study of iatrogenic nerve injuries related to dental practice is ambiguous. The adverse events associated with using aesthesia in routine dental practice are rare, with insufficient available data. Thus, to answer the question about the prevalence of iatrogenic injuries related to dentistry, we need an unrealistically large sample size reviewed retrospectively.

About 93% of the injuries had iatrogenic causes, whereas 7% (3) of them were caused by non-iatrogenic causes, which is relatively greater than earlier study which recorded 89.5% of iatrogenic injury cases, whereas 10.5% (39) had other causes of neuropathy [1]. Contrary

to what was reported by other studies, in this study, IAN is affected more often than the LN [1,4]. In another study, less than 20% of cases reported pain on injection; however, in this study, almost 40% (17) of the cases reported experiencing pain on injection [1].

This study has several limitations that should be highlighted. The time frame for data collection was limited to 2 weeks. Also, there was no equality in the questionnaire distribution since students filled most questionnaires without equal distribution in approaching the other participants (dentists and interns). Furthermore, the questionnaire has drawbacks; for instance, the type of intervention used by the participants was not included. Also, gender was not included in the variables to be assessed. Finally, there was significant recall bias since the participants had to report the case based on their memory. Larger sample size is needed to approach considerable results.

On the contrary, some strengths of this study must also be noted. To date, this is the only study done in Saudi Arabia regarding the prevalence of iatrogenic nerve injuries reported by dental practitioners. Also, the study covered the experiences of all levels of dental practitioners, including students, interns, and dentists. In addition, it was distributed in educational, governmental, and private clinics. Further studies are recommended to investigate the actual reported cases of TNIs in depth by accessing data retrospectively, revealing the degree of incidence documentation via dental practitioners.

Conclusion

In conclusion, most cases (93%, $n = 44$) presented with neuropathy due to iatrogenic injury. Extraction was the most encountered procedure accounting for 65% of the injuries, followed by restorative and implant procedures that account for 27.3% of the injuries. Among all reported cases, 81.8% caused temporary symptoms, and 75% affected the mandibular branch. It was found that 57% of TNIs were encountered by general practitioners. Most of these injuries (70%) were referred to OMF surgeons for follow-up.

To sum up, an appropriate assessment, thorough history, and clinical examination would significantly help prevent TNI cases. Moreover, well documentation and prompt reporting and referral by the clinicians would ensure optimum patient care. Therefore, further studies covering the main Saudi regions other than Riyadh city are advocated to establish preventive and management protocols.

List of Abbreviations

OMF	Oral and Maxillofacial
TNIs	Trigeminal Nerve Injuries

Conflict of interests

The authors declare that there is no conflict of interest regarding the publication of this article.

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None.

Consent to participate

Informed consent was obtained from all the participants.

Ethical approval

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