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Title page

Work-related traumatic dental injuries:

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Running title: Incidence and characteristics of occupational dental traumas

Keywords: epidemiology, occupational dental trauma, dental fracture, pre-existing dental condition

Conflict of interest

Alessandro Ugolini, Giovanni Battista Parodi, Claudia Casali, Armando Silvestrini-Biavati and Flavio Giacinti state that there are no conflicts of interest.

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Work-related traumatic dental injuries: Prevalence, characteristics and risk factors

Background/Aims: The prevalence of work-related oral trauma is underestimated because minor dental injuries are often not reported in patients with several injuries in different parts of the body.

In addition, little data are available regarding their characteristics. The aim of this epidemiological study was to determine the prevalence, types and characteristics of occupational traumatic dental injuries (TDIs) in a large working community.

Materials and Methods: Work-related TDIs that occurred during the period between 2011 and 2013 in the District of Genoa (Northwest of Italy, 0.86 million inhabitants) were analyzed. Patients' data were obtained from the National Institute for Insurance against Accidents at Work database.

Results: During the 2 years period, 112 TDIs (345 traumatized teeth) were recorded. The prevalence was 5.6% of the total amount of occupational trauma. The highest prevalence was found in the fourth and fifth decades of life (OR=3.6, $p<0.001$) and males were injured more often than females (70.5% vs 29.5%, OR=2.8, $p<0.001$). Service and office workers represented 52% of the sample and construction/farm/factory workers and craftsmen were 48%. TDIs involved only teeth and surrounding tissue in 66% of cases, or in combination with another maxillofacial injury in 34%. They were statistically associated with construction/farm/factory workers group (Chi2 $p<0.01$). Crown fracture was recorded in 34.5% of cases, subluxation/luxation in 10.7%, avulsion in 9%, root fracture in 3.8% and concussion in 3.5%. Thirty-two subjects (28.6%, 133 teeth, OR=4.3, $p<0.001$) presented at least 1 traumatized tooth with previous dental treatment. Among 212 (61.4%) traumatized teeth, 67.5% were upper incisors, 17.5% were lower incisors, 3.3% were upper canines, 1.9% were lower canines and 9.9% were bicuspid and molars.

Conclusions: Work-related TDIs had a low overall prevalence and fractures were the most frequent dental injury. Age, gender and pre-existing dental treatments represented risk factors for work-related TDIs.

Running title: Prevalence and characteristics of occupational dental trauma

Keywords: epidemiology, occupational dental trauma, dental fracture, pre-existing dental condition

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Introduction

Acute work-related trauma is a leading cause of disability among workers. It has been estimated that worldwide there are more than 270 million workplace injuries annually which resulted in the loss of 3.5 years of healthy life for every 1,000 workers.¹⁻² Oral trauma is common in patients with multiple injuries, but the occurrence of several injuries in different parts of the body that require emergency treatment may result in minor oral injuries being underreported, so their frequency may be underestimated.

Oral trauma causes injuries to the mouth, especially to the teeth and periodontal tissues. They are not frequent and make up to 5% of all injured parts of the body of all ages.³ Traumatic injuries to the dento-alveolar region (including trauma to teeth, alveolar bone and gingival lacerations) may involve maxillo-facial fractures and/or soft tissues injuries. Dental injuries range from minor damage, such as enamel infraction, to major damage, such as tooth avulsion or alveolar bone fractures. Dental trauma may also cause necrosis of the dental pulp, which requires root canal treatment. Such injuries cause significant emotional and social costs to patients and their families. In addition, the treatment involves economic costs in the short term (restoration of the damaged dentition) and in the long term (assistance and renewal of the prosthetic rehabilitations). Recent studies estimate that the prevalence of traumatic injuries ranged between 6 and 39% and data from many countries showed that one third of adults have suffered from trauma to the permanent dentition, as reviewed by Zaleckiene et al.⁴ In the literature, only a few studies have focused on work-related maxillo-facial trauma⁵⁻¹² and only one has investigated occupational dental trauma.¹³ However, there is no data about the type and characteristics of work-related dental injuries. The aim of the present epidemiological study was to investigate frequency, types and characteristics of traumatic dental injuries (TDIs) in a large working community.

Materials and Methods

In the present cross-sectional study, the STROBE guidelines and checklist for an observational study was followed. Data were collected for the period between September 2011 and September 2013 in the District of Genoa, Italy. The eligibility criteria were the occurrence in the study period of a work-related dental injuries claimed by the workers to the “National Institute for Insurance against Accidents at Work” (INAIL). INAIL supports the workers by giving them financial and medical support in the event of occupational accidents or diseases. The final sample comprised 112 work-related episodes of dental trauma, including accidents occurring “en route” to or from the workplace. The same senior INAIL dental consultant (A.U.) visited all the patients with occupational dental trauma and the dental diagnosis was made according to the epidemiological dental injury classification provided by the World Health Organization (WHO)¹⁴ (Table 1). An objective structured oral and extra-oral examination was performed for each patients following the

Clinical Guidelines provided by Italian National Dentist Association. During the structured clinical examination, three categories of variables were recorded: anamnestic interview variables (gender, age, season of trauma, working category), oral and dental variables (dental formula, presence and type of dental treatments, characteristics of dental injuries such as concussion, luxation, crown or root fracture, avulsion, trauma to alveolar bone and gingivae) and presence of other concomitant facial injuries (as reported by Emergency or Maxillo-Facial Department). For the present study, all diagnoses were blinded checked by another INAIL senior dental consultant (G.P.). In case of diagnosis disagreements not solved by discussion, the patients were excluded from the study. The examiners undertook a calibration process for the WHO diagnostic criteria: they randomly re-examined 15 patients in order to verify the intra-examiner error. Mean kappa value combined for intra- and inter- of 0.95 for the WHO diagnostic criteria were obtained during this phase.

Descriptive analysis was used to summarize trial and patient characteristics. Chi square or Fisher's exact tests were performed, when appropriate, to analyze the differences among the groups. Probabilities of less than .05 were accepted as significant in all statistical analysis. The odds ratios (OR) of suffering from work-related TDIs and co-presence of risk factors (age, gender, season of the trauma, working category) were calculated using a multivariate model. The association between outcome and explanatory variables was evaluated by setting the significance level to a p value of less than or equal to 0.05.

Results

During the 2 years period included in the study, 19,938 workers reported an occupational trauma in the Genova Metropolitan area¹⁵ and among these, 112 (79 males and 33 female, ratio m/f 2.5:1, mean age 41 years old, range 19-67) were referred to a Dental consultant for a dental injury. The overall prevalence (2012 and 2013) was 5.6‰ (5.7‰ in the first year and 5.5‰ during the second year) of the total number of occupational accidents and 0.16‰ (0.17‰ and 0.15‰) of the total number of workers. Multivariate analysis (Table 2) found that age ($p < 0.01$; OR=3.6) and gender ($p < 0.01$; OR=2.8) represented a risk factor for work-related TDIs. With regards to age, the highest prevalence was found in the fourth and fifth decades of life (40-49 years old, $n=37$, 33%; 50-59 years old, $n=29$, 26%) but there was no age difference by gender. Males were statistically more often injured than females (70,5% vs 29,5%) and there was not any statistically significant difference in the number of accidents in relation to any seasons of the year. Service and office workers represented 52% ($n=58$, m/f 42/16) of the injured people and construction, farm, factory workers and craftsmen were 48% ($n=54$, m/f 37/17) of the sample. Trauma involved only teeth and surrounding tissue in 66% ($n=74$) of cases, and occurred in combination with another maxillofacial injuries (facial soft tissues injuries and/or facial bone fractures) in 34% ($n=38$) of the subjects. There was a statistically significant association between dental injuries and concomitant maxillofacial injuries in

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construction/farm/factory workers group, which was not found in the office/service workers group (26/47, 55% vs 12/65 18%, Chi2 $p < 0.01$). "En route" accidents represented 18% ($n=20$) of the sample. In the office workers group 8 out of 12 (66%) dental injuries occurred during an "en route" accident were associated with maxillofacial fractures.

The type and characteristics of the injuries to the 345 traumatized teeth (recorded in 112 patients) are summarized in Tables 1 and 3. A statistically significant association was detected between the occurrence of occupational dental trauma and type of teeth (upper incisors represented the 67,5% of the sample; OR=12.1, $p < 0.01$) and the presence of previous dental treatment ($p < 0.01$; OR=4.3). Thirty-two subjects (28.6%) presented with at least 1 traumatized tooth that had previous dental treatment (onlay, inlay, single crown w/o implants, bridge) for a total of 133 teeth (38.6%).

Discussion

In Italy work-related accidents and occupational diseases are managed by the National Institute for Insurance against Accidents at Work (INAIL). INAIL has supported nearly all workers since 1883 by giving them financial and medical support in the event of occupational accidents or diseases. Since the year 2000 (Law Identifier: D.Lgs. 38/2000)¹⁶, INAIL has also covered accidents occurring on the way to and from the workplace. The Genoa District (Provincia di Genova) has 0.86 million inhabitants (database of The National Institute for Statistics on 31/12/2013)¹⁶ and the total number of workers in the Genoa District is 339,602 which represents 1.5% of the country's workforce (total Italian workforce is 22,632,000).¹⁷ After an occupational dental trauma has been claimed, the injured workers are first visited by the INAIL dental consultant, who is a Doctor in Dental Surgery (DDS). The role of the consultant is to analyze the characteristics of the trauma, to decide whether the dental damage claimed is directly connected to the work-related accident or not, and to report any pre-existing tooth conditions and/or dental damage. Then, the consultant has to write a report with the restoration plan for the damaged teeth of the patient, including the maximum refundable sum, which refers to a prearranged price list provided by Italian National Dentist Association.¹⁸ After the clinical examination by the INAIL dental consultant, the patient is referred to a private dental service, in order to restore the damaged dentition. Then, before being refunded, the patient has to undergo a second clinical appointment with the INAIL dental consultant, which is a test visit, in order to verify the correspondence of the dental rehabilitation to the original restoration plan. In the current study, the same senior INAIL Consultant (A.U.) visited all the patients with occupational dental trauma that had occurred in the District of Genoa between September 2011 and September 2013. Genoa District (North-west of Italy), is a region which included both urban/suburban area (Genova is the

sixth Italian city by population) and rural area (country, mountain and coastal territories).¹⁶ Due to this geographical conformation, most of jobs/professions are represented.

Unfortunately, INAIL does not provide data about dental and maxillofacial injuries. In the literature there are only a few studies focusing on these subjects⁵⁻¹² and only one refers to occupational dental trauma.¹³ Occupational dental injuries are often associated with maxillofacial trauma and considered as collateral damage. Hence there are only a few studies of maxillofacial injuries that report data on dental trauma frequency,⁵⁻⁸ but the dental injuries are not properly recorded and described, or the sample is not representative of the entire population. Only the study performed by Trullas and al.¹³ focused on occupational dental trauma. Their sample consisted of 250 cases recorded over a period of 6-years (from 2000 to 2006) in FREMAP Hospital in Barcelona (Spain). The prevalence of the injuries was reported to be 1.71 per 1000 occupational accidents. The frequency calculated by Trullas et al.¹³ was lower than the prevalence found in the present study, which was 5.6 per 1000 accidents over a 2-years period. The clinical diagnostic method explained the significant frequency difference: Trullas et al.¹³ stated that not all dental injuries may have been recorded because their physicians were not dentists and they did not have adequate diagnostic tools. In the present study, a senior dentist performed a structured clinical dental examination of all patients claiming work-related dental accidents. The frequency of the dental injuries was higher among males than females (ratio 2.5/1) and the results are similar to those found by Trullas et al.¹³ but very different from those reported in other occupational maxillofacial trauma studies.^{7,8,10} These studies reported a striking dominance of male accidents^{7,8,10} which is explained by the majority of the sample in the cited studies being farmers, construction or factory workers, and male workers are usually more frequently engaged in physical and dangerous work than female workers.^{5,6-8,10} In the present study, 52% of the sample were office and service workers, and 48% were farmers, construction, factory workers and craftsmen. These differences in the sample related to working categories, reflect not only the difference in male/female ratio, but also the higher mean age of the sample, which was similar to the Italian study of Rocca et al.⁸ and the lower percentage of maxillofacial related injuries. Office and service workers (52% of the sample) often suffered from minor trauma which involved only teeth and surrounding tissue, without bone fractures, except for “en route” accidents, whose there was a high rate of maxillofacial related injuries in the office workers group (66%). If the construction/farm/factory workers group only is considered, the percentage of associated maxillofacial injuries was similar to those found in the previous study cited.^{5,6-8,10}

Only Trullas et al.¹³ and Hacl et al.⁶ have reported data about different types of work-related dental injuries. However, both suffered from methodological bias. In the Trullas et al. study¹³, the physicians that made the dental diagnosis were not dentists, whilst in Hacl et al. study,⁶ the physician proficiency was not stated and the Department in which they enrolled the patient was not the only referral center for occupational

maxillofacial trauma in the Innbrusck area (Austria). Hence their sample was not representative of the population, as it was in the present study and in the Trullas et al. study.¹³

The main dental injuries were crown and/or root fractures (38.3% of the patients). The percentage is lower than in Trullas et al. (54%)¹³ and Hachl et al. (53%)⁶, because only natural tooth fractures were considered. However, if the percentage of the single restored tooth fractures (11.9%) were added (bridges and full arch fixed prosthesis are excluded), the overall fracture percentage reaches 50.2%, which is similar to Trullas et al.¹³ and Hachl et al.⁶ Incisors were the most commonly involved teeth in fracture accidents. They represented 85% of the events, and of these, 67.5% were upper incisors. In the literature, there is no data reporting pre-existing conditions in patients with dental trauma. In the present study, of the 345 damaged teeth considered, 212 (61.4%) were natural teeth and 133 (38.6%) were restored teeth (onlays, inlays, bridges, single crowns w/o implants, endodontically treated teeth, full arch rehabilitations). Hence, the data reported not only suggests that any tooth which has already been treated or restored is weaker than a natural tooth, but also shows the impact of the previous therapy on the dental trauma prevalence, since more than one third of the injuries occurred to an already treated tooth. This finding underlines that even a very low energy trauma (e.g. office injuries) can lead to dental damage in a tooth with a pre-existing restoration.

CONCLUSION

The main findings were:

- The prevalence of occupational dental trauma was 5.6 per 1000 occupational accidents and 0.16 per 1000 workers.
- Males were significantly more often injured than females and the highest prevalence was found in the fourth decade of life.
- Concomitant maxillofacial trauma occurred in 34% of the accidents and were mainly associated with construction/farm/factory workers.
- Service and office workers suffered mainly from low energy impact accidents and the damage involved only the teeth.
- Fractures were the most frequent dental injury (50.2%) and the upper incisors were significantly the most involved teeth with fractures (67.5%).

- A high frequency of pre-existing dental conditions was found: 39% of the fractured teeth had previous dental treatment and represented a risk factor for increased damage in work-related TDIs.

Conflict of interest: The authors confirm that they have no conflict of interest.

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Ethical Statement for DT-02-17-OA-3450.R3 - Work-related traumatic dental injuries: Prevalence, characteristics and risk factors

I testify on behalf of all co-authors that our article submitted to "Dental Traumatology":

Title:

All authors: Work-related traumatic dental injuries: Prevalence, characteristics and risk factors

- 1) this material has not been published in whole or in part elsewhere;
- 2) the manuscript is not currently being considered for publication in another journal;
- 3) all authors have been personally and actively involved in substantive work leading to the manuscript, and will hold themselves jointly and individually responsible for its content.

Date: 25 September 2017

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Table 1. Type of dental injury (code according to WHO)¹⁶

Injuries to the hard dental tissues and the pulp	n°	%
Enamel infraction (N 502.50)	18	5.2
Enamel fracture (N 502.50)	43	12.5
Enamel- dentin fracture (N 502.51)	32	9.3
Complicated crown fracture (N 502.52)	26	7.5
Root fracture (N 502.53)	13	3.8
Injuries to the periodontal tissues		
Concussion (N 503.20)	12	3.5
Subluxation/Luxation (N 503.20/21)	37	10.7
Avulsion (N 503.22)	31	9.0
Fracture of restored teeth		
Onlay, inlay, single crown w/o implants, endodontic treatment	133	38.6

Table 2. Multivariable analyses and significant interactions. OR= odds ratio; 95% CI= 95% confidence interval.

Variable	Work-related TDIs			
	OR	95% CI		p value
Age	3.6	2.43	5.63	<0.01*
Gender	2.8	1.23	4.58	<0.01*
Seasons of the year	0.9	0.52	1.71	0.53
Working Category	1.3	0.63	3.16	0.28
"En route" accidents	1.2	0.52	2.34	0.48
Types of teeth (incisors. canines. premolars. and molars)	12.1	5.36	27.12	<0.01*
Tooth with previous dental treatment	4.3	1.89	8.21	<0.01*

Table 3. Work-related TDIs characteristics (n = 345 traumatized teeth)

Percentage and type of teeth involved in the trauma	
Bicuspid/Molars	9.9%
Upper Canines	3.3%
Lower Incisors	17.5%
Lower Canines	1.9%
Upper Incisors	67.5%
Number of teeth involved in each accident	
3 or more teeth	44.0%
2 teeth	31.9%
1 tooth	24.2%
Characteristics of dental injuries	
Avulsion	9.0%
Fracture of restored teeth	38.6%
Crown fracture	34.5%
Luxation	10.7%
Root fracture	3.8%
Concussion	3.5%