Java project on periodontal disease. Periodontal condition in relation to vitamin C, systemic conditions and tooth loss

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Chapter 5

Java Project on Periodontal Diseases:

Causes of tooth loss in a cohort of untreated individuals

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Abstract

Objective: To assess the relative contribution of caries and periodontal disease to tooth loss over 24 years in a cohort deprived of regular dental care.

Material & Methods: The study population consisted of 98 subjects from the Purbasari tea estate on West Java, Indonesia, that had been part of a prospective longitudinal study and provided full datasets of clinical assessments from 1987, 1994 and 2002. In addition, in 2011 a complete set of dental radiographs was obtained which was combined with the survey forms and clinical slides of the previous research for the evaluation of tooth loss.

Results: 37 subjects lost no teeth, whereas 61 subjects lost 185 teeth. In this latter group 45.9% lost ≤2 teeth, 32.8% lost 3 to 4 teeth and 19.7% lost ≥5 teeth. The majority of teeth were primarily lost due to caries. In 5 subjects tooth loss could be attributed solely to periodontal disease, whereas in 4 subjects teeth were lost due to both caries and periodontal disease. Analyses of the predictor variables age, gender, smoking habits and education level showed that only increasing age was significantly related with tooth loss.

Conclusion: The majority of teeth in this population were lost due to caries.

Introduction

Tooth loss is an important aspect of oral health because it impairs esthetics, chewing function and as a consequence quality of life (Gerritsen et al. 2010). Cross-sectional epidemiological studies identified, in addition to caries and periodontal disease, a number of risk indicators for tooth loss e.g. smoking (Mai et al. 2013), education level (Urzua et al. 2012) and socio-economic status (Wennström et al. 2013). In most cases, teeth are not spontaneously lost but extracted by dentists or physicians for reasons of pain, caries, periodontal disease, endodontic complications or as part of orthodontic and prosthodontic treatments. In general, caries and periodontal disease are regarded as the main reasons for tooth loss although the relative contribution of these two diseases varies between studies. In this respect, numerous studies have been carried out all over the world. Many studies concluded that caries is the main reason for tooth extraction (Chestnutt et al. 2000, Chrysanthakopoulos et al. 2011, Corbet & Davies 1991, Hull et al. 1997, Jafarian & Etebarian 2013, Jovino-Silveira et al. 2005, Lee et al. 2012, McCaul et al. 2001). However, several other studies showed the opposite, as periodontal disease was found to be the main reason for tooth extraction (Akhter et al. 2008, Haddad et al. 1999, Murray et al. 1996, Phipps & Stevens 1995, Reich & Hiller 1993). It has also been reported that caries and periodontal disease are equally important reasons for tooth extraction (Aida et al. 2006, Angelillo et al. 1996, Ong et al. 1996). These diverse results are most likely due to e.g. differences in socio-economic status, oral health care delivery systems, dental awareness and dentist to population size ratio.

Due to all the above mentioned variables, it is difficult to study the natural history of tooth loss. Therefore, prospective longitudinal studies evaluating tooth loss in populations deprived of oral health care are very valuable. In this respect two studies are of interest, i.e. the study on the natural history of periodontal disease in humans in Sri Lanka (Löe et al. 1978) and the study of Baelum et al. (1997) in a population of rural Chinese. In the Sri Lankan study, the rate of natural periodontal destruction was evaluated in a population free of caries (Neely et al. 2005), whereas in the Chinese population caries was found to be the predominant cause of tooth loss. Another prospective study on the natural history of periodontal disease has been carried out in Java, Indonesia (Van der Velden et al. 2006). The first evaluation was carried out in 1987 with follow-up assessments in 1994 and 2002. In 2011 a further study on this population was initiated with the aim to investigate alveolar and periapical bone loss as visible on radiographs in relation to demographic, lifestyle, dietary, and subgingival microbial variables as well as some blood chemistry parameters. The results

of the 2011 evaluation concerning alveolar bone loss and related potential predictors have been described in a separate paper (Amaliya et al. 2014). The purpose of the present study was to investigate 1. the relative contribution of caries and periodontal disease to tooth loss over the 24 year period, and 2. to analyze the prevalence of caries and its sequelae on the radiographs taken in 2011.

Material and Methods

In 2011, 123 subjects of the original Indonesian study population (Van der Velden et al. 2006) were retrieved and informed in detail about the objectives of this study. Thereafter they were asked if they would be willing to participate. The study was approved by the Ethics Committee of the Hasan Sadikin Hospital Bandung-West Java, Indonesia. The subjects who volunteered signed an informed consent form. Subsequently, various variables were assessed including: age, gender, smoking habits and education level. Non-smokers included 3 former smokers who stopped smoking 9 months, 3 and 18 years ago respectively. Details on the study protocol and results on periodontal bone loss in relation to environmental and systemic conditions have been reported previously (Amaliya et al. 2014).

In order to determine the cause for tooth loss, first the absence of teeth was assessed on a full set of dental radiographs taken for this study in 2011 (Amaliya et al. 2014). Next, the survey forms of the research carried out in 1987, 1994 and 2002 were used, in which information was available considering all teeth except the third molars. These forms included not only the periodontal parameters, but also the presence/absence of teeth as well as an annotation for teeth that, from a periodontology point of view, were impossible to evaluate due to extreme tooth decay. Also, open caries and root remnants of a particular tooth were noted. In addition, clinical photographs (frontal, left and right lateral view as well as occlusal view in case of open caries) were used to check and confirm the notes on the survey forms.

Radiographic examination

A full set of dental radiographs, including vertical bite wings, were obtained of each subject using a long cone paralleling technique (Gnatus Timex 70 X-Ray Mobile Column, Brazil). At each tooth radiolucencies representing caries and its sequelae were scored in the following way:

1. No caries
2. Caries into the dentine
3. Caries into the pulp with no widened periodontal ligament space
4. Caries into the pulp with widened periodontal ligament space
5. Caries into the pulp with an evident periapical radiolucency
6. Root remnant in the bone with no/ widened periodontal ligament space
7. Root remnant in the bone with an evident periapical radiolucency
8. Root remnant not in contact with the jaw bone

Statistical analysis

Descriptive statistics and data analyses were performed with statistical software from SPSS (version 19.0; IBM SPSS Inc., Chicago, IL, USA). The relationship between the dependent variable presence or absence of tooth loss (on a subject level) and the predictor variables age (youger/older than median age), gender, smoking habits (smoker/non-smoker) and education level (elementary school completed/non-completed, junior high school completed), was first determined using the Spearman's rank correlation test. Variables that showed a correlation (p-value <0.10) were included in a binary logistic regression analysis (backward stepwise with $p \leq 0.05$ to enter and $p \geq 0.10$ to leave). For all outcome analyses, p-values <0.05 were considered statistically significant.

Results

Of the 123 retrieved inhabitants of the Purbasari tea estate, 98 subjects volunteered to participate in the present investigation. The cohort population included 53 woman and 45 men with a mean age of 45.6 years, ranging from 39 to 50 years. Evaluation of the radiographs showed complete absence of dental restorations and a mean number of 1.9 (± 2.2) lost teeth. Presence of tooth loss and number of lost teeth in relation to gender, smoking habits and education level are presented in Table 1.

Table 1. Tooth loss in 2011 in relation to background characteristics

Variables	Percentage of subjects with lost teeth	Mean (SD) number of lost teeth
All subjects (N=98)	62.4	1.88 (2.19)
Gender		
Female (N=53)	54.9	1.87 (2.21)
Male (N=45)	71.1	1.91 (2.19)
Smoking		
Non-smokers (N=54)	60.4	1.96 (2.17)
Smokers (N=44)	64.4	1.80 (2.23)
Education: elementary school		
Not completed (N=54)	64.9	2.04 (2.41)
Completed (N=44)	59.1	1.70 (1.90)

Comparisons within each predictor variable showed no significant differences, however correlations were found between presence of tooth loss and male gender (p=0.09) and increasing age (p=0.02). In the following logistic regression analysis only age proved to be significant (p=0.039, 95% C.I. Exp^{β}: 1.005, 1.207).

In 2011, 37 subjects had lost no teeth at all, whereas in 61 subjects 185 teeth were lost. In this latter group 45.9% of the subjects lost ≤ 2 teeth, whereas 32.8% lost 3 to 4 teeth and 19.7% lost ≥5 teeth (Table 2).

Table 2. Total number of lost teeth by subject (N=98) at the surveys in 1987, 1994, 2002 and 2011.

	Year of survey and number of subjects			
Number of lost teeth per subject	1987	1994	2002	2011
0	86	77	61	37
1	7	14	15	21
2	3	5	11	8
3	2	1	5	7
4		1	6	13
5				4
6				4
7				3
10				1
>10				—
Total number of lost teeth	19	31	76	185

Retrospectively, in 1987 at baseline, already 19 teeth were lost in 12 subjects. In 1994 this increased to 31 teeth lost in 21 subjects and in 2002 to 76 teeth lost in 37 subjects. Critical analysis of the data revealed that in the majority of subjects most teeth were lost due to caries and its subsequent sequellae (Table 3). In only 5 subjects tooth loss could be attributed solely to periodontal disease, whereas in 4 subjects teeth were lost most likely due to both caries and periodontal disease.

Table 3. Cause for tooth loss as assessed in 2011 by subject (N=61), teeth and tooth type

Cause for tooth loss	Number of subjects (%)	Number of teeth (%)	Molars (N)	Premolars (N)	Anteriors (N)
Caries	52 (85.2%)	149 (80.5%)	126	16	7
Periodontitis	5 (8.2%)	12 (6.5%)	7	2	3
Caries and periodontitis	4 (6.6%)	24 (13.0%)	15	5	4

Molar teeth were most frequently lost (80.0%), followed by premolars (12.4%) and anterior teeth (7.6%). The predominant influence of caries is also reflected in an increase in number of root remnants during the study follow-up. This was in 2011 almost the same amount as the number of teeth already lost (Table 4). When root remnants and lost teeth are taken together,

20 subjects still had a full dentition in 2011 whereas 78 subjects lost ≥1 functional tooth ranging from 1-13 (mean 3.7±3.59).

Table 4. Total number of root remnants by subject (N=98) at the surveys in 1987, 1994, 2002 and 2011.

Number of root remnants per subject	Year of survey (number of subjects)			
	1987	1994	2002	2011
0	79	65	51	34
1	14	19	13	23
2	2	6	12	15
3	2	5	7	10
4	1	1	7	4
5		0	0	4
6		2	1	3
7			0	2
8			1	1
9			1	2
>9				—
Total number of root remnants	28	62	109	177

In Table 5, data of the prevalence of caries and its sequelae are presented per tooth type. As is apparent, most of the teeth present were caries free varying between 71.6% for the upper right second molar to 100% of almost all lower incisors. With respect to all teeth present, crown caries was rare. Only 1.7% showed caries into the dentin and 1.4% into the pulp chamber. Root remnants were more frequently encountered since these amounted to 6.7% of the teeth still present. Evident peri-apical lesions related to teeth with caries into the pulp chamber and root remnants, were found in 0.7% and 3.3% of all teeth respectively. No or minimal peri-apical lesions amounted to 0.7% and 1.9% respectively. Root remnants that were no longer in contact with the jaw bone amounted to 1.5% of all teeth. Remarkably, some root remnants present on the radiographs in 2011 had already been present as root remnants at the first clinical examination, 24 years previously, in 1987.

Table 4. Total number of teeth in 98 subjects and prevalence of caries and its sequelae of these teeth by tooth type.

Tooth type	# teeth present	No caries # teeth (%)	Caries into dentin # teeth (%)	Caries in pulp and no/minimal peri-apical lesion # teeth (%)	Caries in pulp and obvious peri-apical lesion # teeth (%)	Root remnant and no/minimal peri-apical lesion # remnants (%)	Root remnant and obvious peri-apical lesion # remnants (%)	Root remnant not in contact with jaw bone # remnants (%)
17	81	58 (71.6)	6 (7.4)	1 (1.2)	-	5 (6.2)	9 (6.9)	2 (1.5)
16	81	62 (76.5)	1 (1.2)	1 (1.2)	-	4 (3.1)	9 (6.9)	4 (3.1)
15	92	84 (91.3)	1 (1.1)	-	1 (1.1)	3 (3.3)	2 (2.2)	1 (1.1)
14	92	81 (88.0)	1 (1.1)	-	1 (1.1)	4 (4.3)	4 (4.3)	-
13	96[1]	88 (91.7)	3 (3.1)	2 (2.1)	-	1 (1.0)	2 (2.1)	-
12	94[1]	89 (94.7)	3 (3.2)	-	1 (1.1)	-	1 (1.1)	-
11	93	90 (96.8)	2 (2.2)	-	-	1 (1.1)	-	-
21	96	92 (95.8)	3 (3.1)	-	-	1 (1.0)	-	-
22	96	87 (90.6)	5 (5.2)	1 (1.0)	-	1 (1.0)	2 (2.1)	-
23	95[2]	92 (96.8)	2 (2.1)	-	-	-	1 (1.1)	-
24	94[1]	80 (85.1)	-	3 (3.2)	-	4 (4.3)	7 (7.4)	-
25	93	80 (86.0)	-	-	-	6 (6.5)	4 (4.3)	3 (3.2)
26	83	61 (73.5)	1 (1.2)	-	1 (1.2)	2 (2.4)	15 (18.1)	3 (3.6)
27	83	66 (79.5)	2 (2.4)	1 (1.2)	2 (2.4)	4 (4.8)	6 (7.2)	3 (3.6)
37	76	63 (82.9)	-	3 (3.9)	2 (2.6)	3 (3.9)	2 (2.6)	3 (3.9)
36	79	64 (81.0)	-	1 (1.3)	4 (5.1)	1 (1.3)	3 (3.9)	6 (7.6)
35	95	86 (90.5)	1 (1.1)	3 (3.2)	3 (3.2)	-	-	2 (2.1)
34	98	91 (92.9)	1 (1.0)	-	-	2 (2.0)	3 (3.1)	1 (1.0)
33	98	97 (99.0)	-	-	1 (1.0)	-	-	-
32	98	98 (100)	-	-	-	-	-	-
31	98	98 (100)	-	-	-	-	-	-

41	97[1]	97 (100)	-	-	-	-	-	-
42	98	97 (99.0)	-	-	-	-	1 (1.0)	-
43	98	94 (95.9)	3 (3.1)	-	-	-	1 (1.0)	-
44	97	92 (94.8)	2 (2.1)	-	1 (1.0)	2 (2.1)	-	-
45	97	88 (90.7)	1 (1.0)	1 (1.0)	1 (1.0)	1 (1.0)	4 (4.1)	1 (1.0)
46	83	67 (80.7)	2 (2.4)	-	1 (1.2)	2 (2.4)	6 (7.2)	5 (6.0)
47	72	61 (84.7)	2 (2.8)	-	-	2 (2.8)	3 (4.2)	4 (5.6)
Total(%)	2553 + 2 impacted 4 agenesis = 2559	2303 (90.2%)	42 (1.7%)	36 (1.4%)		172 (6.7%)		

[1] agenesis of one tooth, [2] impaction of two cuspids.

Discussion

In most studies that have evaluated the cause of tooth loss, dentists were asked to record the reason for tooth extraction and to provide this information to the researchers (Angelillo et al. 1996, Chestnutt et al. 2000, McCaul et al. 2001, Aida et al. 2006). A more reliable method to investigate the cause of tooth loss is to collect teeth extracted by dentists with the information why the tooth was extracted (Hull et al. 1997). In epidemiological studies in developing countries it appears much more difficult to assess with certainty the reason for tooth loss and the researcher has to rely on the information provided by the examinee (Baelum & Fejerskov 1986). The strength of the present study is that on the basis of recorded information over a 24 years period, it was possible to assess the reason for tooth loss with a high degree of certainty for all teeth. The results of the study showed, that in the population under investigation, which was deprived from regular dental care, most teeth were lost due to caries and its sequellae. Notably, the finding that dental restorations were absent, confirms that this population was really deprived of any regular dental care. Nevertheless, the possibility cannot be ruled out that some teeth were extracted as emergency treatment for severe toothache because at the tea estate a small hospital was present for medical care of the residents living in the many villages on the estate. In the early days of the study general physicians and in more recent years visiting dentists may have been consulted by residents having severe pain with subsequent tooth extraction. According to discussions with medical staff at the hospital this was however a rare phenomenon.

The first examination of the subjects of the present study took place in 1987 when the age ranged between 15-25 years. At that time most third molars, if present, were partially erupted and therefore not included in the study. Results of the present study, with the population now aged 39-50 years, show that no one had become edentulous. The mean number of 1.9 actual lost teeth (from total 28) is not particular high. When the number of root remnants are summed with the number of missing teeth this results in 3.7 lost functional teeth. It is interesting to compare the average number of truly lost teeth (1.9) with other study populations also having limited access to dental health care and of approximately the same age. For example, a mean of 5 lost teeth (of 32) has been reported in adult Tanzanians with an age range of 40-49 years (Baelum & Fejerkov 1986). In a rural Chinese population with the same age range, on average, 4 teeth (of 32) were lost (Baelum et al. 1997) and in a remote living indigenous population in Guatemala aged 45-54 years, 3.8 teeth (of 32) were lost (Dowsett et al. 2001). Higher figures have been found in rural populations of Sri Lanka. In the classical study of Löe et al. (1978) 5.8 teeth (of 28) were lost at the 20 years follow-up

evaluation (Neely et al. 2005). At that time the age range was 35-50 years. Furthermore, Amarasena et al. (2003) reported a mean loss of 4 teeth (of 28) in the age group 35-44 and of 8.3 teeth in 45-54 year olds. Even higher tooth loss numbers were found in an isolated rural population in Brazil (Corraini et al. 2009). In this population the age group 40-49 years had lost 13 (of 28) teeth.

In the above mentioned studies the reason for tooth loss varied considerably between caries and periodontal disease. In the Tanzanian study (Baelum & Fejerkov 1986) the primary cause of tooth loss was caries. In Sri Lanka the prevalence of caries has been shown to be extremely low (Ekanayaka 1984) and even absent in the subjects of the classical study on the natural history of periodontal disease (Neely et al. 2005). In the Brazilian study from Corraini et al. (2009) it was concluded that both caries and periodontal disease were significant explanatory variables for the extensive tooth loss. The results of the present study showed that the majority of teeth were lost due to caries despite the fact that it is a population with moderate to severe periodontitis (Amaliya et al. 2014). Also, apparent was that it takes many years before spontaneous exfoliation occurs of teeth that have been affected by periodontitis. Taking into account the present low prevalence of crown caries in this population, it may be expected that in the future in this population most likely more teeth will be lost due to periodontal breakdown. In other words, apparently first the carious susceptible teeth are lost followed by the periodontitis susceptible teeth. In this respect a relatively older population may show more teeth lost as a result of periodontitis.

It is an intriguing question why the cause of tooth loss is so different between the study population on the natural history of periodontal disease in Sri Lanka (Neely et al. 2005) and the present Indonesian study population. Both populations are workers on a tea estate in mountainous areas approximately 1500m above sea level having little communication with the society outside the estate and a comparable diet consisting mainly of rice and vegetables with some meat or fish. Both populations drink tea sweetened with sugar. Löe et al. (1978) mentioned that the fluoride content of the drinking water at the Sri Lanka tea estate was 0.02-0.07 ppm. Since in the Indonesian study population tea was the most popular drink, a representative cup of tea was brought back to the Netherlands in order to assess the fluoride content. Analysis showed that it contained approximately 0.45 ppm of fluoride (Van der Velden et al. 1993). Since none of the above mentioned variables readily explain the difference in caries prevalence, the question remains what actually caused the discrepancies in caries susceptibility of these two populations.

In agreement with the observation in other studies on tooth loss in rural populations (Baelum et al. 1986, Baelum et al. 1997, Corraini et al. 2009), it was found in the present study that molars were the most frequently missing teeth. In addition, the molars showed the highest number of root remnants as well. It was interesting to note that for those root remnants still in the jaw bone, in approximately half of the cases no or minimal peri-apical radiolucencies were found whereas at the other half evident and sometimes very large peri-apical lesions were present, and probably for many years.

Worldwide, the prevalence of dental caries among adults is high as the disease affects nearly 100% of the population in the majority of countries (Petersen et al. 2005). It has also been reported that oral biofilm-associated diseases, and their subsequent diseases and conditions, have broad implications on oral health-related quality of life (Beikler & Flemmig 2011). In the present study population 80% of the subjects had lost on average 3 functional teeth, mostly molars, due to caries and its sequellae. In conjunction with the relatively high prevalence of periodontitis in this population (Amaliya et al. 2014), it is likely to have had a negative effect on the quality of life. If oral disease burdens are to be reduced or preferably prevented, significant changes in approaches, concepts and policies are required (Benzian et al. 2011).

In conclusion, results of the present study showed that in this Indonesian population of tea workers on Java, deprived of regular dental care, tooth loss over a period of 24 years was limited. Although this population suffered from moderate to severe periodontitis, the majority of teeth were lost due to caries and to a minor extent due to periodontal disease. Improvement of dental awareness and education in oral hygiene measures in such populations might reduce both diseases and could improve quality of life.

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