Oral health and dental status in people with epilepsy in rural China

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Abstract

Purpose: We evaluated the oral health and dental status of people with epilepsy, and their relationship to seizure frequency, in a community cohort in rural China.

Methods: A cross-sectional study of people with epilepsy was carried out in areas in Henan, Shanxi and Ningxia provinces of China. All participants underwent a specially designed "Oral health and Dental status Questionnaire". Univariate and multivariate analyses were used to explore the relationships between seizure frequency and oral health and dental status.

Results: A total of 875 people participated. Almost two thirds (65.8%) reported brushing their teeth at least once a day but 634 (73.0%) brushed their teeth for less than 3 minutes each time. Only 80 (9.1%) had visited a dental clinic in the previous year. Multivariate logistic regression analysis showed that having 1-4 seizures/month (OR 0.60, 95%CI 0.40-0.90) or >4 seizures/month (OR 0.38, 95%CI 0.22-0.66) was associated with decreased odds of brushing teeth at least once a day, and higher seizure frequency was associated with increased odds of dental injury due to seizures (OR 2.07, 95%CI 1.22-3.50 for <1 seizure/month; OR 2.12, 95%CI 1.25-3.58 for 1-4 seizures/month; OR 3.09, 95%CI 1.57-6.07 for >4 seizures/month).

Conclusion: Seizure frequency was significantly associated with seizure-related dental injury, and with the lack of good oral health practice. Improvement in the oral health of people with epilepsy in resource-poor areas should be encouraged.

Keywords: seizure frequency; dentistry; buccal hygiene; oral sampling; dental caries; tooth loss

1. Introduction

Epilepsy is characterized by recurrent seizures [1]. It is the second most common neurological condition in China with a prevalence of around 0.7%; this translates into just over 9 million people with epilepsy among whom an estimated 6 million have active epilepsy [2]. People affected by epilepsy have a significantly worse quality of life as well as more compromised physical and psychological health levels than the general population[3,4].

Oral health, as defined by WHO, is a condition of being free from chronic oro-facial ache, oral sores, dental caries and tooth loss, periodontal diseases, or other factors that affect the well-being of the oral cavity [5]. Oral health, influencing the whole body directly or indirectly, is one determinant factor for quality of life [6,7]. Oral diseases can destroy the hard tissues of the teeth and the supporting tissues around the teeth, thus impairing not only the functions of chewing, speech, and aesthetics, but also social interaction and psychological state [5]. A close interrelationship has been demonstrated between oral and general health [6,7]. Some microorganisms in the oral cavity may, over time, cause or exacerbate certain systemic diseases such as diabetes or coronary heart disease[7,8].

Most existing oral health-related studies in epilepsy focus on gingival hyperplasia induced by anti-epileptic drugs (AEDs) [9–11]. Previous reports showed that people with epilepsy have poorer oral health status and awareness than people without epilepsy[12,13]. There is a dearth of data concerning oral health and dental status of people with epilepsy in resource-poor areas.

During a study involving the acquisition of DNA samples from people with epilepsy in rural communities in China, we aimed to obtain oral samples using swabs or saliva. During a pilot study, it became clear that this would not yield usable samples, largely due to contamination from oral flora. This led us to evaluate the oral health and dental status of people with epilepsy, as well as their relationships to seizure frequency, in these communities.

2. Methods

2.1. Study site and participants

Permanent residents in the study sites were eligible to participate. People with epilepsy previously recruited within the study "Validation of Clinical Assessment Tools for Population Genetic Studies of Epilepsy (1R21NS069223-01, NIH/NINSD)" from rural communities in Henan, Shanxi, and Ningxia provinces in China were asked to participate. Subjects were excluded for the following reasons: 1) seizures resulting from progressive systemic or neurological disorders, 2) nonepileptic attack disorder, 3) seizures related to drug or alcohol abuse, 4) lack of adequate assessment of seizure control or of whether the individuals adhere to their drug regime, 5) pregnancy, 6) presence of severe cognition or motor impairments and 7) inability to provide consent (from individuals or their guardians).

2.2. Clinical assessment and diagnosis of epilepsy

Clinical assessment was done in two steps. In step 1, trained village physicians

interviewed individuals who had history of seizures. Family members who had witnessed seizures or were familiar with their medical history were also interviewed. In step 2, neurologists from the designated provincial epilepsy centre reviewed individuals who had been identified in step 1 and confirmed or refuted the diagnosis of epilepsy. This was based on clinical symptoms and on a comprehensive history including details of any potential risk factors for epilepsy (such as history of status epilepticus, febrile seizures, history of central nervous system infections, brain injury, stroke, and brain tumour, and family history of epilepsy (in close relatives), abnormal birth history), and results of neuro-imaging and EEGs which were available during this step. A group of experienced neurologists with a special interest in epilepsy (PK, JWS, and ZH), reviewed the diagnoses and any conflicts were resolved by consensus. Data collection included: 1) demographics; 2) age of onset; 3) seizure classification (focal without secondary generalization, focal with secondary generalization, or generalized, based on ILAE guidelines[14]); 4) seizure frequency (categorized as seizure free, <1 seizure/month, 1-4 seizures/month, >4seizures/month); 5) putative aetiology of epilepsy (classified as structural/metabolic, genetic, or unknown)[14]; 6) treatment history (whether or not the individual had had more than one year of AED treatment).

2.3 Questionnaire of oral health and dental status

Village physicians, who had been provided with basic training in oral health by experienced dentists, interviewed participants or their relatives using a specifically

designed “Oral health and Dental status Questionnaire (ODQ)” (see Box 1). Questions addressed tooth brushing habits, visits to dental clinics, oral symptoms and diagnosis, number of caries, history of dental injury, tooth loss, and dental restoration experience, based on experts’ opinions from dentists and epileptologists in China.

2.4 Standard protocol approvals, registrations, and informed consent

The initial study was approved by the joint Chinese University of Hong Kong-New Territories East Cluster Research Ethics Committee and by the Ethics Committee of the Beijing Neurosurgical Institute in China. The oral health survey was approved by the Medical Ethics Committee of Huashan Hospital Fudan University, Shanghai, China. All participants provided informed consent; where applicable participants’ legally acceptable guardians provided assent.

2.5 Statistical approach

Continuous variables were expressed as median (minimum, maximum), and categorical variables as counts and frequencies (%). The Chi-square test was used for comparing categorical variables. One-way ANOVA or the Kruskal-Wallis test were used to compare continuous variables among 4 groups (seizure-free, <1 seizure/month, 1-4 seizures/month, >4 seizures/month) according to whether or not the data were normally distributed. Unadjusted and adjusted odds ratios and 95% confidence intervals (95% CI) were calculated using univariate and multivariate logistic regression models in order to explore the association between seizure

frequency (seizure-free group as the reference) and oral health and dental status. Multivariate logistic regression was fitted, adjusting for potential confounders based on previous literatures and experts' clinical experience. The confounders included age (as a continuous variable), age of onset (as a continuous variable), sex, etiology of epilepsy (genetic, structural/metabolic, and unknown), seizure type (focal without secondary generalization, focal with secondary generalization, and generalized), and more than one year's treatment with antiepileptic drugs (AED) (yes, no).

All p-values and 95% CIs were estimated in a two-tailed fashion. Differences were considered to be statistically significant at $p<0.05$. Data were analyzed using SPSS 22.0 (SPSS Inc., IL,USA).

3. Results

3.1 Demographics and clinical characteristics of participants

A total of 875 people with epilepsy were included and their demographics and clinical details are given in Table 1. The majority (805; 92.0%) had taken AEDs for more than a year. Almost half (402; 46.0%) had seizures at least once a month and only 206 (23.5%) were seizure free.

3.2 Oral health and dental status by seizure frequency

Two thirds (576; 65.8%) reported brushing teeth at least once a day and the remainder did not brush regularly (Table 2). The majority (634; 73.0%) brushed their teeth for less than 3 minutes each time. Less than ten percent (80; 9.1%) had visited a

dental clinic in the previous year. Just under half (395; 45.1%) had dental symptoms, of whom 16.7% had gingival hyperplasia. Fifteen people of the 130 taking phenytoin had gingival hyperplasia. Nearly forty percent of participants (344; 39.3%) reported having caries. Only sixty-two (7.1%) had ever been formally diagnosed with a dental disease. Overall, 225 (25.7%) had missing teeth due to caries, and almost one fifth (19.0%) had injured teeth as a result of seizures.

Table 2 suggests that frequency of brushing teeth (p=0.011), whether caries were present (p=0.027), missing teeth due to seizures (p=0.025), and dental injury due to seizures (p=0.044) was statistically significant among four groups with different severity of seizure frequency (seizure-free, <1 seizure/month, 1-4 seizures/month, >4 seizures/month).

3.3 Unadjusted and adjusted odds ratios for factors related to seizure frequency using logistic regression models

Table 3 shows that, after adjusting for the confounding factors (age, age of onset, sex, aetiology of epilepsy, seizure type, and whether individuals had had more than one year of AED treatment), frequent seizures [1-4 seizures/month (OR 0.60, 95%CI 0.40-0.90) and >4 seizures/month (OR 0.38, 95%CI 0.22-0.66)] were associated with decreased odds of brushing teeth at least once a day. Higher seizure frequency was associated with increased odds of dental injury due to seizures (OR 2.07, 95%CI 1.22-3.50 for <1 seizure/month; OR 2.12, 95%CI 1.25-3.58 for 1-4 seizures/month; OR 3.09, 95%CI 1.57-6.07 for >4 seizures/month). The lowest seizure frequency (<1

seizure/month) was associated with a lower probability of caries than those seizure free (OR 0.61, 95%CI 0.41-0.91).

4. Discussion

This is one of the first community-based attempts to evaluate the oral health and dental status of people with epilepsy in resource-poor areas. Our findings suggest that people with epilepsy in rural China have poor oral health and are vulnerable to dental injury. There seems to be a significant association between seizure frequency and regularity of brushing teeth and seizure-related dental injury using multivariate logistic regression analyses.

Oral health is a significant part of physical and mental health but it is often neglected, particularly in people with epilepsy. Our findings show that fewer than 1 in 10 had visited a clinic in the previous year, which is lower than the approximately 16% attendance at dental clinics reported in rural areas [15]. We also found that less than one third brushed their teeth for at least 3 minutes each time and around one third did not brush teeth regularly. Participants with higher seizure frequency were less likely to brush their teeth regularly and this may be due to the fact that people with more severe epilepsy are less likely to self-care [16]. It is possible that oral health may be improved through public oral hygiene education and perhaps also by effective control of the individuals' seizures[13]. The present finding may imply a lack of awareness of oral health. People with epilepsy may not deem oral issues a high priority, unless they have severe pain or discomfort. The lower socioeconomic status of people with epilepsy, especially those with recurrent seizures, may also partly

account for the relatively lower frequency of dental visits.

About a fifth had experienced at least a seizure-related dental injury. Previous studies found a higher risk of dental trauma in people with epilepsy than in the general population [17–20]. Dental injury has been reported as the most common hard tissue injury resulting from seizures [21]. Previous studies have also related seizure frequency with increased dental injuries[3,20]. A Brazilian study showed that dental injury was more common in people with epilepsy, affecting up to a third, but was even more common if the person did not have a useful aura prior to seizures[22]. The incidence of dental injury in Nigeria was also much more common amongst people with epilepsy than in the general population[13,23]. The unpredictability of seizures may lead to falls and accidents causing serious physical injury[24,25]. In many settings, it is not uncommon for a person having a seizure to have a spoon or other object placed in the mouth; this may lead to dental injury [17,26]. The powerful contraction of the masticatory muscles during convulsions may also play a role in dental injuries[12]. Convulsive seizures often result in minor oral lesions, such as bitten tongues, but also frequently cause dental injuries and, under some conditions, traumatic oro-facial injuries[27].

All participants on AED treatment were using cheaper AEDs, such as phenobarbital or phenytoin; gingival hyperplasia is a common complication, particularly of phenytoin treatment. The incidence of hyperplasia in people taking phenytoin in our study was much lower than widely reported[28,29]. The variance between studies may be a result of mild gingival hyperplasia being easily missed by individuals

without subjective symptoms and with inadequate oral health education, or missed without comprehensive oral examinations. Mild gingival hyperplasia is less likely to induce strong emotional reactions and may therefore be under-reported. The aetiopathogenesis of drug-induced gingival hyperplasia is still not clear but likely multifactorial[30]; poor oral hygiene has been suggested as an important determinant[31].

Physicians and dentists need to cooperate in the management of people with epilepsy. Oral health should not be ignored by physicians and promptly refer those who require dental care, as dentists have an important role to play.

Our study has limitations. Firstly, most demographic, clinical and oral health data were self-reported by the participants, and recollection retrieved from the past; this may lead to reporting bias (such as under-reporting of stigmatizing behaviors or over-reporting of healthy behaviors) and recall bias. Secondly, confounders such as levels of education and income, literacy, household poverty indices and nutritional status would also be expected to be associated with adverse dental outcomes. We could not adjust for these confounders in our model due to the limitation of the data. Participants were, however, all rural residents with similar socio-economic backgrounds. Thirdly, we had no controls, but were able to compare our findings to previous reports. Lastly, it is possible that village physicians may not have properly identified oral symptoms or diseases so this may have led to underestimation of the problems. To avoid this, future studies should include full dental examinations, performed under standard dentistry conditions.

5. Conclusions

Oral hygiene routine in people with epilepsy in rural China seems precarious and this results in poor oral health which may impact quality of life. Seizure frequency was significantly associated with seizure-related dental injury, and with bad oral health habits in people with epilepsy in rural China. Therefore, control of seizures must take precedence in epilepsy. As a determinant factor of quality of life, every effort should be made to improve oral health and dental status, especially in people who are already detrimentally overwhelmed by their condition.

Disclosures

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Ethical publication statement

We confirm that we have read the journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Table 1 Demographics and clinical characteristics of people with epilepsy

	People with epilepsy n=875
Age (years), median (range)	41 (8-9)
Age of onset (years), median (range)	14 (0-77)
Gender	
Male, n (%)	529 (60.5)
Etiology	
Genetic, n (%)	158 (18.1)
Structural/Metabolic, n (%)	251 (28.7)
Unknown, n (%)	466 (53.3)
Seizure type	
Focal without secondary generalization, n (%)	62 (7.1)
Focal with secondary generalization, n (%)	467 (53.4)
Generalized, n (%)	346 (39.5)
Having more than one year of AED treatment, n (%)	805 (92.0)
Seizure frequency	
Seizure free, n (%)	206 (23.5)
<1 seizure/month, n (%)	267 (30.5)
1-4 seizures/month, n (%)	313 (35.8)
>4 seizures/month, n (%)	89 (10.2)

Table 2 Oral health and dental status of the study participants by severity of seizure frequency

		Seizure frequency				
	Total (N=875)	Seizure free (N=206)	<1 seizure/month (N=267)	1-4 seizures/month (N=313)	>4 seizures/month (N=89)	P value
Brush teeth regularly						
No, n (%)	299(34.2)	59(28.6)	87(32.6)	110(35.1)	43(48.3)	0.011
>=once, n (%)	576(65.8)	147(71.3)	180(67.5)	203(64.8)	46(51.7)	
Brushing time*						
<3min, n (%)	634(73.0)	144(70.6)	196(74.5)	226(72.4)	68(76.4)	0.685
>=3min, n (%)	234(27.0)	60(29.4)	67(25.5)	86(27.6)	21(23.6)	
Visit dental clinics in the previous year>=once, n (%)	80(9.1)	20(9.7)	25(9.4)	25(8.0)	10(11.2)	0.777
Dental symptoms, n (%)	395(45.1)	97(47.1)	120(45.0)	139(44.4)	39(43.8)	0.965
Toothache, n (%)	180(45.6)	43(44.3)	54(45.0)	63(45.3)	20(51.3)	0.898
Bleeding gums, n (%)	164(41.5)	34(35.1)	52(43.3)	60(43.2)	18(46.2)	0.506
Swollen gums, n (%)	124(31.4)	22(22.7)	45(37.5)	44(31.7)	13(33.3)	0.135
Gingival hyperplasia, n (%)	66(16.7)	13(13.4)	19(15.8)	24(17.3)	10(25.6)	0.377
Bad breath, n (%)	172(43.5)	45(46.4)	44(36.7)	62(44.6)	21(53.8)	0.224
Others, n (%)	11(2.8)	1(1.0)	4(3.3)	4(2.9)	2(5.1)	0.566
Caries, n (%)	344(39.3)	96(46.6)	95(35.6)	124(39.6)	28(31.5)	0.027
Median (range)	2(1-32)	2(1-28)	2(1-24)	2(1-32)	2(1-30)	0.795
Missing teeth due to caries, n (%)	225(25.7)	68(33.0)	66(24.7)	75(24.0)	16(18.0)	0.025
Median (range)	2(1-32)	2(1-28)	2(1-24)	2(1-32)	2(1-28)	0.687
Dental injury due to seizures, n (%)	166(19.0)	26(12.6)	56(21.0)	62(19.8)	22(24.7)	0.044
Tooth fracture due to seizures, median (range)	1(0-32)	1(0-9)	1(0-10)	1(0-32)	2(0-6)	0.220
Tooth detached/extracted due to seizures, median (range)	1(0-32)	2(0-27)	1(0-10)	1(0-32)	2(0-25)	0.108
Dental injury for other reasons, n (%)	63(7.2)	16(7.8)	25(9.4)	17(5.4)	5(5.6)	0.295
Tooth fracture for other reasons, median (range)	1(0-15)	1(0-10)	1(0-15)	0(0-8)	0(0-2)	0.969
Tooth detached/extracted for other reasons, median (range)	1(0-28)	2(0-10)	0(0-6)	1(0-28)	2(0-5)	0.163
Natural tooth loss except change to adult teeth, n (%)	105(12.0)	29(14.1)	40(15.0)	29(9.3)	7(7.9)	0.082
Natural tooth loss except change to adult teeth, median (range)	2(1-28)	3(1-28)	2(1-28)	2(1-28)	2(1-25)	0.793
Dental restorative treatment, n (%)	178(20.3)	54(26.2)	53(19.9)	56(17.9)	15(16.9)	0.113
Dental crown, n (%)	27(15.1)	6(12.5)	8(16.0)	10(18.9)	3(21.4)	
Dental prosthesis, n (%)	127(71.3)	40(83.3)	40(80.0)	37(69.8)	10(71.4)	
Others, n (%)	11(6.2)	2(4.2)	2(4.0)	6(11.3)	1(7.1)	
Dental diagnosis, n (%)	62(7.1)	14(6.8)	24(9.0)	17(5.4)	7(7.9)	0.413
Pulpal and Periapical disease, n (%)	26(41.9)	3(21.4)	12(50.0)	9(52.9)	2(28.6)	0.220
Gingivitis, n (%)	37(59.7)	9(64.3)	12(50.0)	9(52.9)	7(100.0)	0.106
Periodontitis, n (%)	21(33.9)	6(42.9)	9(37.5)	4(23.5)	2(28.6)	0.672

Others, n (%)	5(8.1)	3(21.4)	1(4.2)	1(5.9)	0(0.0)	0.205

**Note: ***The total number of participants having data of brushing time data was 868. Among them, 204 were seizure-free, 263 had <1 seizure/month, 312 had 1-4 seizures/month, and 89 had > 4 seizures/month.

Table 3 Unadjusted and adjusted odds ratios for factors related to seizure frequency using logistic regression models

Seizure frequency	Brushing teeth at least once a day		Dental injury due to seizures		Presence of caries		Missing teeth due to caries	
	OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value	OR (95%CI)	P value
Univariate analysis								
Seizure free (reference)	1		1		1		1	
<1 seizure/month	0.83(0.56-1.23)	0.358	1.84(1.11-3.05)	0.019	0.62(0.43-0.90)	0.012	0.66(0.44-0.99)	0.044
1-4 seizures/month	0.74(0.51-1.08)	0.122	1.72(1.05-2.83)	0.032	0.74(0.52-1.06)	0.097	0.64(0.43-0.94)	0.024
>4 seizures/month	0.43(0.26-0.72)	0.001	2.26(1.20-4.26)	0.012	0.51(0.30-0.87)	0.012	0.44(0.24-0.82)	0.009
Multivariate analysis*								
Seizure free (reference)	1		1		1		1	
<1 seizure/month	0.72(0.48-1.09)	0.120	2.07(1.22-3.50)	0.007	0.61(0.41-0.91)	0.015	0.70(0.46-1.09)	0.115
1-4 seizures/month	0.60(0.40-0.90)	0.013	2.12(1.25-3.58)	0.005	0.84(0.57-1.24)	0.381	0.82(0.54-1.26)	0.375
>4 seizures/month	0.38(0.22-0.66)	0.001	3.09(1.57-6.07)	0.001	0.65(0.37-1.15)	0.143	0.69(0.35-1.34)	0.267

Note: The P values in the table were derived from the Wald test.

*Multivariate analyses were fitted after controlling for age, onset age, sex, epilepsy etiology, seizure type, and whether the individual had more than one-year of AED treatment.

Box 1: Oral health and dental status questionnaire

Oral Health and Dental Status QUESTIONNAIRE (ODQ)

1. Do you brush your teeth regularly?
   ( ) 0. No 1. Yes, brush teeth____a day, about____minutes each time
2. How many times did you visit dental clinics due to oral problems in the previous year: ____times
3. Do you have the following symptoms frequently:
   1) Toothache: ( ) 0.No 1.Yes 2) Bleeding gums: ( ) 0.No 1.Yes
   3) Swollen gums: ( ) 0.No 1.Yes 4) Gingival hyperplasia: ( ) 0.No 1.Yes
   5) Bad breath: ( ) 0.No 1.Yes 6) Others: ( ) 0.No 1.Yes_____
4. Do you have caries?
   ( ) 0.No 1.Yes,_____number
5. Do you have any tooth detached or extracted due to caries?
   ( ) 0.No 1.Yes,_____number
6. Have you ever suffered from dental injury due to seizure?
   ( ) 0.No 1.Yes,_____number, fracture_____, completely detached or extracted_____
7. Have you ever suffered from dental injury for other reasons?
   ( ) 0.No 1.Yes,_____number, fracture_____, completely detached or extracted_____
8. Apart from the change to adult teeth as a child, have you ever experienced natural tooth loss?
   ( ) 0.No 1.Yes,_____number
9. Have you had your tooth repaired after dental injury or tooth loss?
   ( ) 0.No 1.Yes ( ) 1) Dental crown 2) Dental prosthesis 3)Others_____
10. Have you ever been diagnosed by your dentists for:
    1) Pulpal and Periapical Disease: ( ) 0.No 1.Yes 2) Gingivitis: ( ) 0.No 1.Yes
    3) Periodontitis: ( ) 0.No 1.Yes 4) Others: ( ) 0.No 1.Yes_____