# Dental Erosion in a Road-Side Battery Technician: Case Report and a Review of the Literature

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**Background:** Tooth wear has been generally described as being caused by erosion, abrasion and attrition. Erosion is currently believed to be the major factor involved in tooth wear, and its contribution in the development of tooth wear may be increasing. Among the numerous causes of erosion, extrinsic factors are the most common. Damage of tooth tissue has been described in battery factory workers due to acidic aerosol, but this has not been reported among roadside 'battery technicians' who dispense acidic solutions with a pipette, and often taste it to determine its 'specific gravity'.

**Case Description:** A 24-year-old man was referred to the authors' clinic for management of his grossly damaged teeth after presenting for oral diagnosis. History and investigation pointed to extensive erosive lesion as a result of abnormal and prolonged use of lead-acid rechargeable battery solution in his workplace.

**Clinical Implications:** These groups of workers are prone to severe dental erosion, thereby compromising their oral function and health. They are also prone to a range of illnesses, especially kidney disease, because the acid solution is significantly rich in dissolved lead. Therefore, medical referral for complete assessment is required when any of this group present with an unexplained associated illness.

**Key words:** battery technician, dental erosion

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Tooth wear is becoming more commonly recognised in both adults and children, with studies suggesting a prevalence of 98% in adults. However, unacceptable pathological levels of wear, possibly requiring treatment are of the order of 6 to 10%, depending on age (Smith and Robb, 1996).

The triad of erosion, attrition and abrasion has been known for many years, erosion is currently believed to be the major factor involved in tooth wear and its contribution in the development of tooth wear may be increasing. Dental erosion is an irreversible loss of dental hard tissue due to a chemical process that does not involve bacteria, and is not directly associated with mechanical or traumatic factors or with dental caries.

Mair (1992) reported that erosion may originate from dietary products, environmental factors and regurgitation. Erosion may also be due to either extrinsic or intrinsic acids (Scheutzel, 1996; Zero, 1996). Dental erosion is commonly caused by dietary factors, especially food or drinks that contain citric acid, that may chelate as well as dissolve calcium ions (Giunta, 1983; Linkosalo and Markkanen, 1985; Jarvinen et al, 1991; Imfeld, 1996; Hellstrom, 1997).

Environmental erosion occurs from occupational exposure to acids or acidic vapour. Dental erosion has been reported in workers exposed to sulphuric

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acid and hydrochloric acid during battery manufacturing (Petersen and Gormsen, 1991) and galvanising factories (Zero, 1996), respectively. Erosion has also been found in wine tasters (Gray et al, 1998; Mandel, 2005) and swimmers who have been trained in poorly maintained pools with a pH of 2.7 (Centerwal et al, 1986). Leonard et al (1997) described the improper use of bleaching agents, particularly those delivered in night guards (5 to 22% sodium perborate gel) as another risk factor for erosion of enamel and dentine. Inappropriate use of some mouth rinses that have low pH values (Addy et al, 1991; Bhatti et al, 1994), oral misuse of medications such as hydrochloric acid tablets (Maron, 1996; Zero, 1996), aspirin (Giunta, 1983; Zero, 1996), vitamin C (Giunta, 1983; Maron, 1996) and salivary substitutes (Meyer-Lueckel and Kielbassa, 2002) can also cause dental erosion.

Intrinsic causes that initiate erosion can originate from regurgitation, for example in morning sickness in pregnancy or in bulimia nervosa (Robb, 1991; Jarvinen et al, 1988) and is a complication of gastrointestinal problems such as hiatus hernia. Howden (1971) and Rytomaa et al (1990) documented the effect of the regurgitated acid on the teeth; they identified the medication used to treat such problems as a cause of tooth wear. Complications of chronic alcoholism, such as gastritis and acid regurgitation, have also been implicated in dental erosion (Simmons and Thompson, 1987; Smith and Robb, 1987).

Voluntary regurgitation may occur in patients with eating disorders (Allen, 1969; Andrew, 1982) and the resultant lesions are thought to be the result of the tongue directing gastric contents forwards during voluntary vomiting with the lateral spread of the tongue protecting the mandibular teeth (Stege et al, 1982; Hellstrom, 1997).

**Fig 1** Severely damaged coronal tooth structure in the maxilla and mandibula.

Extrinsic acid erosion caused by the use of acid solution by roadside battery technicians has not been reported. Most common lead-acid rechargeable batteries contain extremely corrosive sulphuric acid with a pH ranging from 2 to 3. Grippo and Simring (1995), Ferguson et al (1996) and Meurman and ten Cate (1996) reported the critical pH at which the enamel dissolves is a range between 5.0 and 5.7, therefore making the acid solution the important causative factor of dental erosion. The salivary concentration of calcium and phosphate normally is supersaturated in relation to enamel hydroxyapatite. An acid environment results in under saturation of this salivary salt, and tooth demineralisation with softening of dental enamel occurs (Touyz, 1994; Attin et al, 1997; Johanson, 2002). The altered enamel now becomes susceptible to wear by masticatory forces and tooth brushing (Stroner, 1983; Hooper et al, 2003).

The dearth of literature on the occupational hazard faced by this group of workers, lack of concern by the dental profession for them in our environment and the serious implication of their practice on oral health, especially dental erosion, make this report imperative.

## CASE REPORT

A 24-year-old battery technician was referred to the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) Restorative Department from the oral diagnosis unit after the diagnosis of pathological tooth wear that was generalised in both arches. The opinion in the clinician's referring note was that the patient would benefit immensely from restorative treatment. A clinical examination and history of the patient was taken in the conservation unit. Ethical approval for the study was obtained from the Ethical committee of Obafemi Awolowo University. Written consent was also received from the patient.

He claimed to have referred himself on account of chipping off of his teeth associated with occasional tooth sensitivity and the inability to chew properly. Medical history showed that the patient was in excellent health. He claimed not to have been on any drug due to compromised health. The patient did not suffer from bruxism or forms of regurgitation and had never swum in a swimming pool. He had not been consuming fruits, fruit juices, carbonated drinks and vitamin C in excessive amounts.

Further questioning regarding the patient's occupation revealed that he usually diluted fresh acid

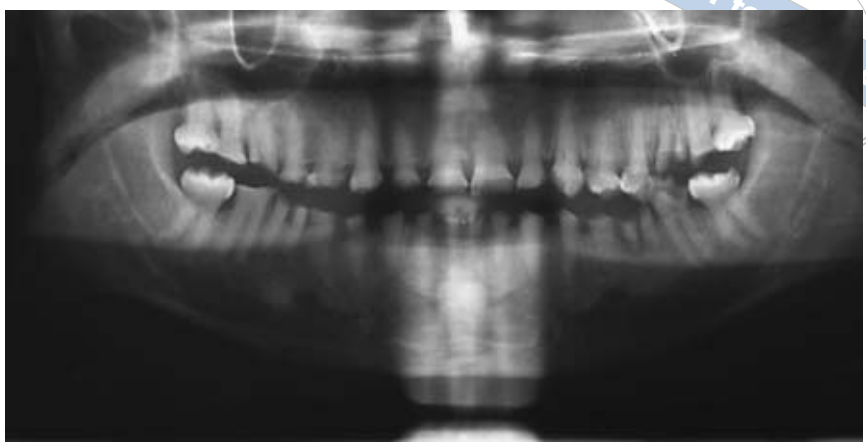

**Fig 2** Dental panoramic radiograph showing the maxillary and mandibular dentition.

solution for new and used batteries before they are charged, and in the process, the mixed solution is often tasted to verify the concentration. He has been practising this at least once every 3 to 5 days for the past 6 years as an apprentice, especially when the workshop's hydrometer was not in working order.

Extraorally, there was reduced facial height, but there were no temporomandibular joint symptoms. Intraorally, the mucosa appeared normal, the gums were healthy and oral hygiene was fair. The obvious abnormality seen was the great destruction of dental hard tissues. Although all the teeth were present, there was irregular enamel loss that was most advanced on the occlusal surfaces of all the teeth except the four wisdom teeth. The mandibular anteriors and the premolars were worn down to the gingival level (Fig 1). The panoramic radiograph (Fig 2) showed partial or complete obliteration of the pulp canals with apical radiolucencies related to the retained roots of the first molars. At this point, extensive dental erosion caused by abnormal and prolonged use of lead-acid rechargeable battery acid was diagnosed.

Treatment included counselling, extraction of all the first molars and overdenture treatment with simple tooth reduction, because of complete obliteration of the dental pulp canals of all the remaining teeth, and also negative reactions after pulp testing. Although no sensitivity was noted, copal vanish was applied on the prepared tooth surfaces immediately after teeth preparation (Fig 3).

Six weeks after extraction, maxillary and mandibular impressions were taken with edentulous stock trays by using alginate impression material. Three days later, secondary impressions were taken with polysulphide impression material.

Bite registration was done 1 week later. The labial fullness of the maxillary and mandibular record rims was adjusted to natural and pleasing position. The resting face height of the patient and the occlusal vertical dimension were measured using the Willis gauge. The Fox bite plane was used to access both the anterior and the posterior occlusal planes. At the correct face height, with the occlusal surfaces making even contact, the record blocks were sealed at the retruded condylar position. The bite blocks with the master cast were then mounted on the articulator. Selection of teeth was done with the patient using Vita shade guide (Vident, California, USA) under natural light. Semi-anatomical teeth were selected for the posterior teeth. Both the maxillary and mandibular anterior teeth were set in front of the alveolar ridge, whereas the mandibular posterior teeth were set over the centre of the ridge, and the maxillary posterior teeth were set to be lateral to the upper ridge. Trying-in of the upper and lower dentures was also done 1 week after the bite registration. The patient was very pleased with the appearance in wax and did not make a request for adjustment. The trial dentures were processed and delivered 3 days later and the patient was very satisfied (Fig 4).

**Fig 3** Simple reduction of the severely worn-down tooth structure.

**Fig 4** The patient smiling after the insertion of the overdenture.

## DISCUSSION

Although cases of acid-damaged teeth have been reported in workers being exposed to sulphuric acid in battery manufacturing factories (Petersen and Gormsen, 1991), hydrochloric acid in galvanising factories (Zero, 1996) and exposure to high levels of hydrochloric acid in improperly maintained chlorinated swimming pools (Centerwal et al, 1986), cases have not been reported among road-side battery technicians.

Roadside battery 'repairing' and charging is an occupation in Nigeria. These workers are commonly seen in towns and cities and operate alongside roadside automobile technicians, with the majority of them being semi-literate. Their actual population is unknown, but they constitute a large portion of the artisans in Nigeria. They dispense sulphuric acid solution in new and used cells with a pipette before they are charged electrically. These acid solutions have pH values that range from 2 to 3 and a specific gravity from 1.5 to 1.8. In the process, the solution often escapes into their mouth during pipetting. Although a hydrometer is usually used to determine the specific gravity of the lead acid, the solution is often tasted to determine the 'specific gravity' when the workshop's hydrometer is faulty and also as a confirmatory test along with the hydrometer.

In the present case, tasting of the acid was done at least once in 3 to 5 days without rinsing until the next meal or day. The presence of the acid in the mouth is assumed to cause salivary stimulation. The dissolution and spread of the acid in the saliva allows the acid to come into contact with the teeth, which are ready substrates for acid attack. This frequent and prolonged exposure to an acid pH of 2 to 3 makes the teeth more likely to be eroded compared with exposure to airborne acids in the work environment (Petersen and Gormsen, 1991). The patient's oral hygiene practices also contributed to the problem, because he did not rinse his mouth after tasting or after accidental escape of the solution into his mouth, thus, increasing the dental contact time of any residual acid. To some extent, the failure to rinse the mouth provided a suitable condition for tooth demineralisation and, thus, softening rapidly occured after acid exposure (Mandel, 2005). Although saliva has a buffering capacity and the ability to form a pellicle (Zero, 1996; Johanson, 2002) can control dental calcification, this physiological protection fails when saliva is overwhelmed by large quantities of a substance with low pH, as is the case in this patient. Thus, the key to this patient's susceptibility to dental erosion can be found, in the first instance, due to ignorance of the destructive effect of a substance with low pH on the oral tissues, and failure to rinse the mouth immediately after acidic insult.

The extensive cupping and wear facets seen in the posterior surfaces of the maxillary molars also revealed the effects of prolonged acid tasting. The destruction of the mandibular anterior teeth was greater than that of the maxillary anteriors. This is possibly due to the fact that the residual acid aided by gravity is made to touch the occlusal surfaces of the mandibular teeth.

Scratching of the exposed dentine surfaces and pulp testing did not provoke any pain or dentine hypersensitivity; this showed that the slow destructive process of dental erosion had allowed enough secondary dentine to form and protect the pulp from tactile and thermal irritations (Nunn, 1996), which was confirmed by peri-apical radiographs and the tomograph (Fig 2).

## CONCLUSIONS

The authors show that inappropriate handling of lead-acid rechargeable battery acids can lead to extensive loss of dental hard tissues. Clinicians, especially in Nigeria, are alerted to watch out for dental erosions in this group of workers and more studies need to be undertaken that can reveal more about the effects of handling lead-acid rechargeable battery acids. It is also important for the dental practitioner and relevant agencies of the government to know this, as they have an obligation to inform the workers, union and the public in general about the danger inherent in lead-acid solution tasting.

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