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ANALYSIS OF METAL DIFFUSION FROM CROWN TO THE HUMAN TEETH

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Summary

Proton induced X-ray emission spectroscopy (PIXE) has been used to determine the intensity of metals from crowns in human teeth. In order to measure elements distribution across the tooth section, proton beam (3 MeV) has been collimeted to provide a spatial resolution of 300 μm.

The samples were selected according to the time of insertion of crowns and the kind of alloys they were made of.

The results show the intensities of gold, zinc and copper in abutment teeth.

It was not found any intensity of paladium and amount of silver was not significant.

Key words: crown, dentin, intensity, metal ions

INTRODUCTION

Air pollution and existing or accidental food contamination is one way for trace elements to incorporate into the human body. Reconstructive treatments in the mouth introduce new substances of inorganic origin and properties into the biological medium. All these contribute in varying degrees to the disorder of biological balance and incorporation into body tissues (1—3).

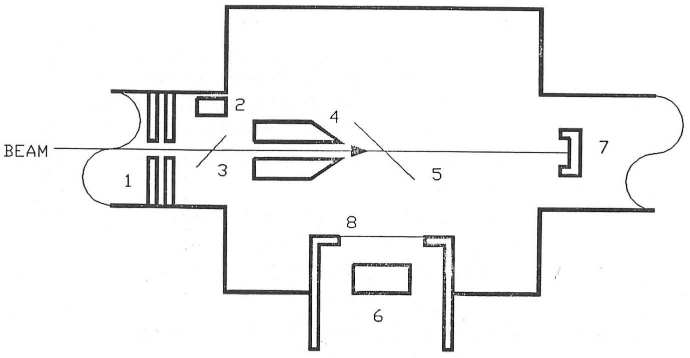
In recent years some authors, using different methods, have been examing the content of healthy human decidious and permanent teeth, and with caries (4—10). They are usualy examining the content of dentin or enamel of the first premolar from 14—16 year old children. For example, Chandhri detected 14 elements in dental cementum (4). Söremark and Lundberg have found in human enamel 11 elements (9).

There is an indication that accumulation of elements in the human dentin is proportional to the concentration of them in human blood, from where these foreign elements usualy segregate very soon.

On the other hand, it is well known that some elements are released from as-cast alloys and go into saliva and body organs (14). That was the basis for the assumption that a similar process is reversible into dentin when the crown is cemented on this tooth.

MATERIAL AND METHOD

Proton induced X-ray emission or PIXE spectroscopy (Fig. 1) was used to analyse extracted abutments in order to establish possible diffusion of trace elements into the teeth. A beam of 3 MeV protons was colimated to provide spatial resolution of 300 m in order to measure the elements' distribution across the section of the tooth.



LEGEND:

1. Collimator
2. Surface Barrier Detector
3. Golden foil
4. Graphite Collimator
5. Sample
6. Si (Li) Detector
7. Faradey Cup
8. Filter

Fig. 1. Experimental chamber

Specimens were attached to an aluminium semple holder with its sectioned surface facing the incoming proton beam.

The crown were made of different alloys (Au-, Au-Pt- and Ag-Pd-alloys) and cemented on the teeth at different times. At first, each crown was removed manualy or sawd from the teeth. Than the teeth were cut by a carborundum or a diamond disk and washed in alcohol.

The control tooth was an intact second premolar from a 14 year old girl.

RESULTS

It has been analysed (A) the tooth with crown from Au-alloy, cemented for a period of 30 years; (B) the tooth with crown from AuPt-alloy, cemented for a period of 3 years; (C) the tooth with crown from AgPd-alloy, cemented for a period of 7 years, and (D) intact tooth.

In each tooth the intensity of main elements in the alloys, Au, Ag, Pd, Cu and Zn were analysed. The results are presented on histograms. The intensity is given on the ordinate in logarithmic scale and distances of the measured points are shown in milimeter on the abscissa. The arrow shows the border between the crown and the teeth.

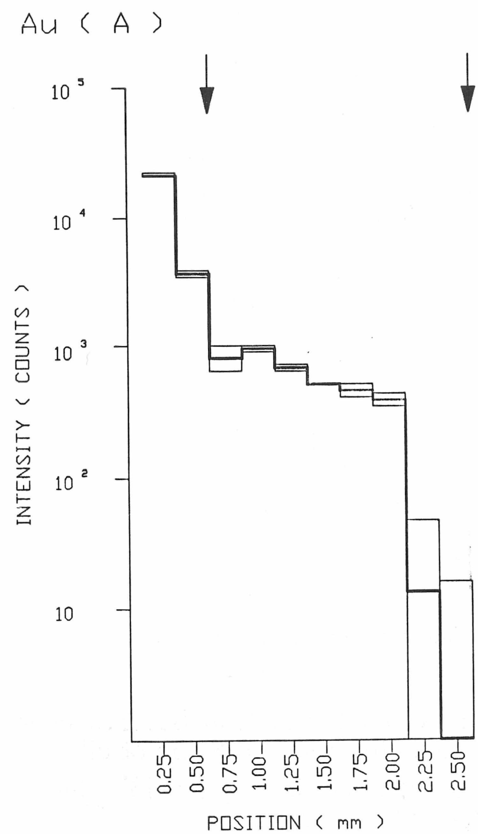


Fig. 2. Distribution profile for gold in sample (A)

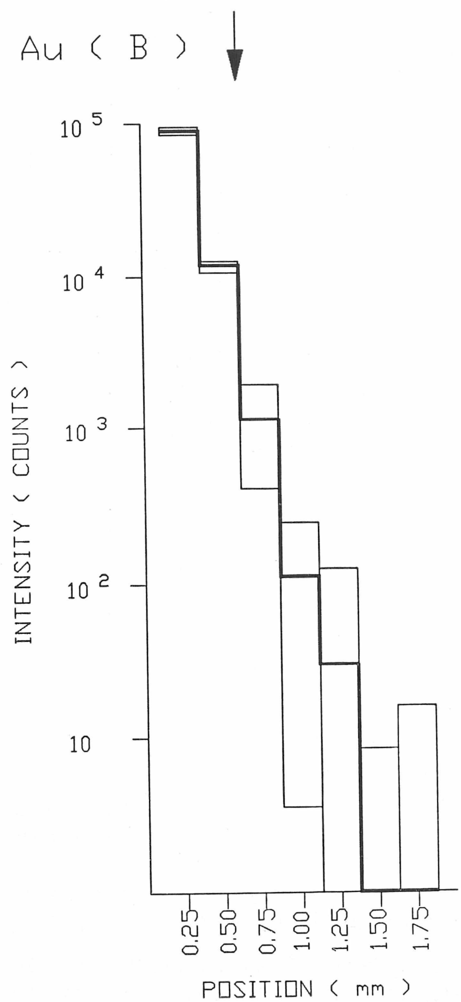


Fig. 3. Distribution profile for gold in sample (B)

The analysis has prown the presence of gold in the abutment tooth (Fig. 2, 3). It is obvious that the intensity of gold depends on haw long the crowns have been cemented on the teeth.

As gold, cooper is the most sensitive element (Fig. 4). The intensity of copper degreeses from the surface to the interior of the tooth, what happens with the intensity of gold too.

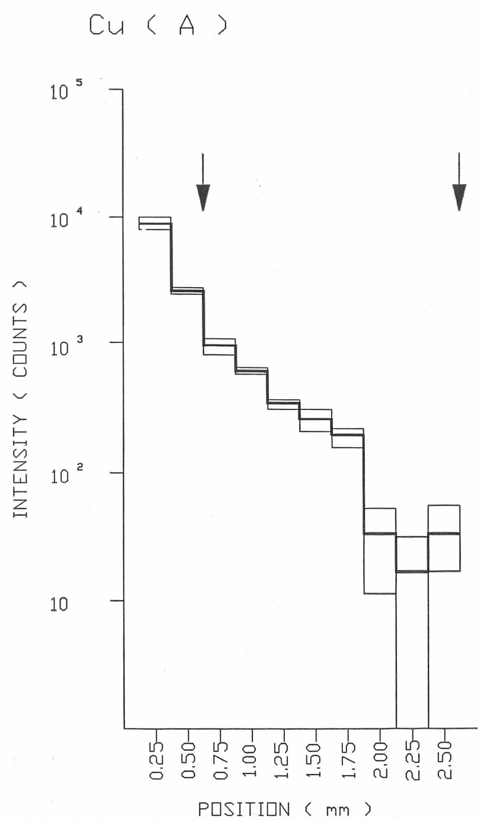


Fig. 4. Distribution profile for copper in sample (A)

The intensity of zinc degreeses starting from the surface, but it reaches a constant level in dentin (Fig. 5). (the same have shown Salbe at all, 5).

Talking about silver, we can say that it has not been proven the intensity of this element (Fig. 6). The same is with palladium.

In the control tooth the intensity of zinc (Fig. 7) and cooper (Fig. 8) is uniform throughaut the whole tooth.

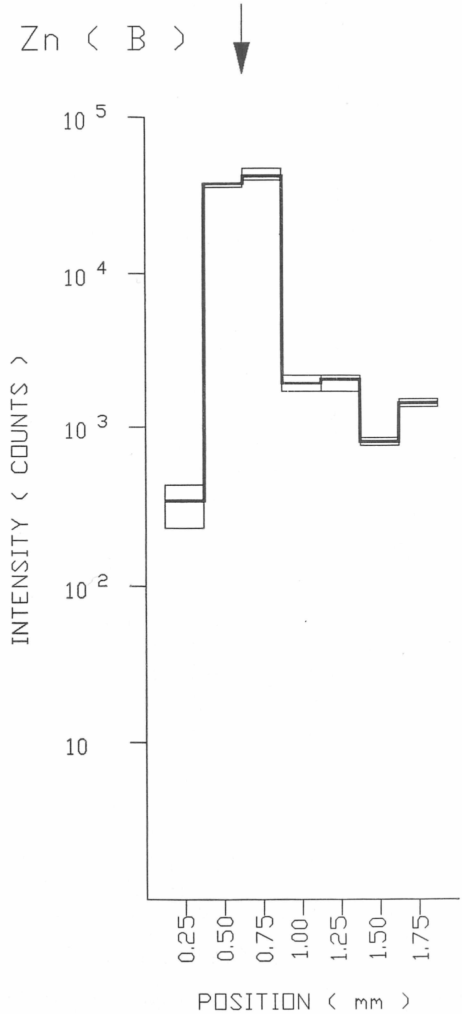


Fig. 5. Distribution profile for zinc in sample (B)

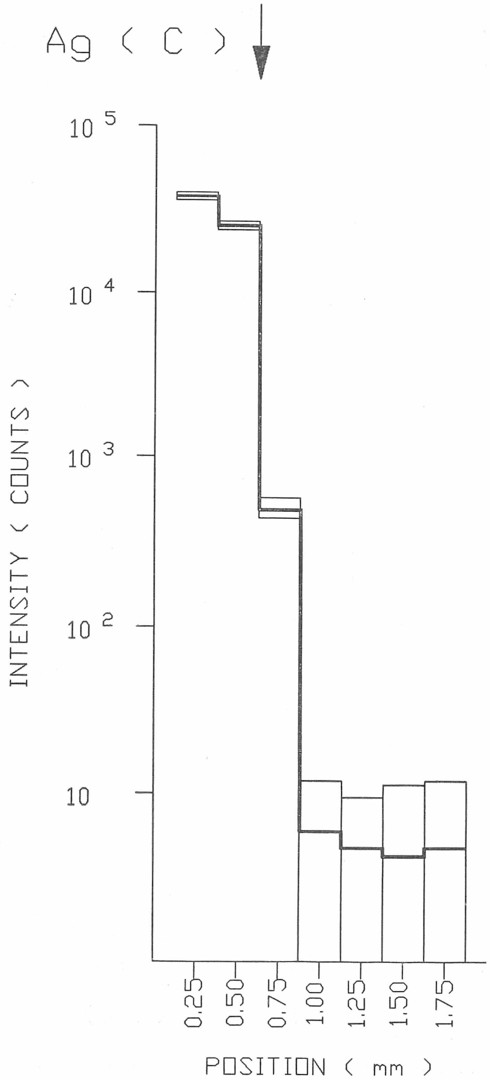


Fig. 6. Distribution profile for silver in sample (C)

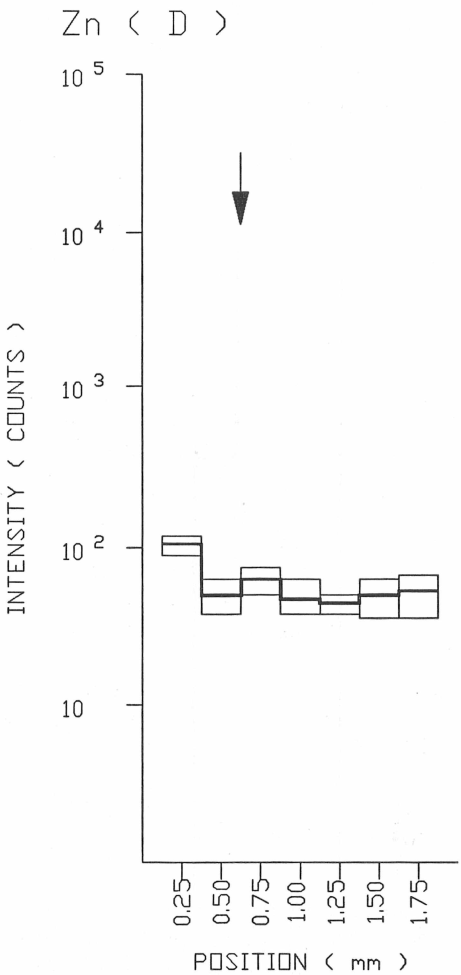


Fig. 7. Distribution profile for zinc in sample (D)

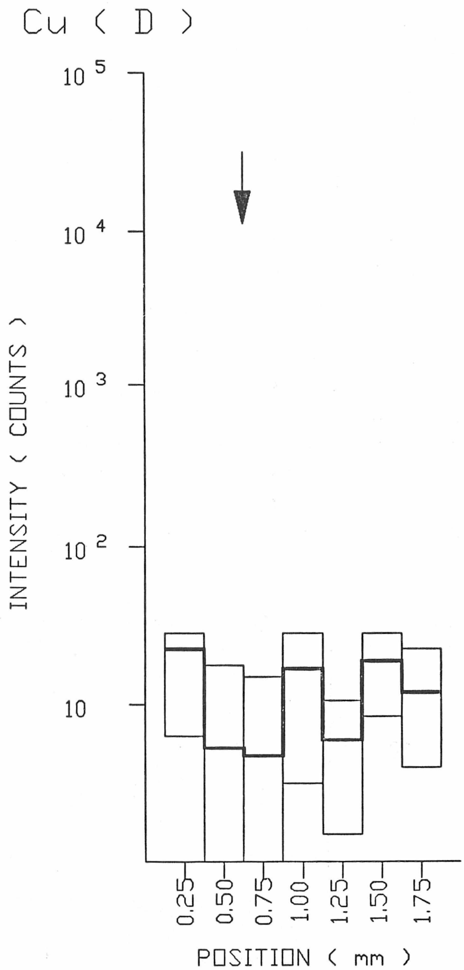


Fig. 8. Distribution profile for copper in sample (D)

DISCUSSION AND CONCLUSION

From this pilot study it is obvious that there is some intensity of metal ions in abutment teeth. The possible explanation for the obtained results is diffusion from the crown and cement layer. The effect of diffusion is especially visible by copper and zinc.

Of course, the intensity of metals depends not only on haw long the crown has been on the tooth, but also on the homogenity of alloy and on tendency of same elements to leave alloy, as when we are talking about copper.

Regarding the trace of silver, there is almoust no diffusion of this element. Silver is insignificantly going into the teeth, iregardless of haw long the crown has been on this tooth.

The obtained trace of silver could be one of the constituents of human dentin, as shown Söremark and Lundberg, but we did not find it in intact tooth.

It could be concluded that gold, zinc and copper have faster mobility than silver and palladium.

However, as copper and zinc are normal components of the tooth structure, and zinc is presented in cement layer, every claim about higher or lower diffusion of thise elements would be presuption. The intensity of these two elements still depends on haw long the crowns were in place, because it is higher in abutments than in the control intact tooth.

Better and safer results would probably be given if the specimens were prepared differently to avoid any contamination, the quantitative values of a detailed analysis of this phenomenon were encluded, and the measuring had been done with better spatial resolutin; as it is, this remains the subject for further examination.

PIXE spectroscopy has proven to be an ideal technic; it needs minimum specimens preparation, it is non-destructive with high sensitivity and it detects broad-range elements.

ANALIZA DIFUZIJE METALA IZ KRUNICE U ZUB NOSAČ

Sažetak

Tehnikom emisije karakterističnih X-zraka, inducirane protonima (PIXE) pokušalo se dokazati difuziju iona metala iz krunice u zub nosač. Distribucija elemenata kroz dentin zuba mjerena je kolimiranim snopom protona (3 MeV), čime se željelo osigurati prostornu rezoluciju od 300 m, tj. što bolje razlikovanje detalja.

Uzorci su selekcionirani s obzirom na trajnost krunica, kao i vrstu legura od kojih su krunice izlivene.

Mjerenjima su utvrđeni intenziteti zlata, cinka i bakra u zubima nosačima, dok intenzitet paladija nije nađen. Za tragove srebra može se reći da su beznačajni.

Ključne riječi: krunica, dentin, intenzitet, ioni metala

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