Measuring the micro-hardness of tooth enamel in dentistry

The enamel – the outermost layer – of the tooth is made of a very hard, abrasion- and acid-resistant calcium-phosphate mineral compound. However, the consumption of chemically aggressive foods, imperfect dental care and mechanical wear and tear all combine to gradually soften or even remove the enamel: once this protective covering is damaged, bacteria can pass through to the core, resulting in tooth decay. Supposedly, dental rinses and toothpastes can protect the enamel and make it more impermeable. But is this effect actually measurable and thereby provable?

Human nutrition has changed greatly over the past few decades. The food industry now offers an enormous variety of tempting food products containing large amounts of sugars and acids, and the average per-person consumption of these soft drinks, snacks and convenience foods has skyrocketed.

Fig.1: Tooth-damaging sweets

At the same time, awareness of daily preventive dental care has also increased significantly. The toothbrush, whether conventional or electric, is now a normal part of nearly everyone's basic personal hygiene regimen. Manufacturers of toothpastes and mouthwashes have developed products to protect the tooth enamel by making it more resistant to the "repeated acid attacks" associated with eating. Various products can prevent, slow down, or even reverse the degradation of already softened surfaces. However, systematic optimisation of these products is only possible if their effectiveness can be tested through accurate measurements.

The Department of Dentistry at the University of Bern was engaged by the Swiss Dental Association (SSO) to investigate the micro-hardness of the enamel, its modulus of elasticity and the relations between the various surface hardnesses. In a controlled experiment, human teeth were subjected to the caustic effects of such beverages as sugary and acidic soft drinks, orange juice and (only seemingly harmless) rose hip tea. The specimens, fixed in an embedding compound, were then measured with the FISCHERSCOPE® HM2000 at a test load of 50 mN. The results showed a significant decrease in surface hardness and elastic modulus compared with the "untreated" enamel. The consequences are obvious: prolonged exposure to acidic liquid can cause tooth decay, because it attacks and softens the tooth enamel.

But, in cooperation with industry, dentistry has found a way to help prevent dental caries and to re-mineralise the tooth through the use of low-dose fluoride. In a second step, the affected teeth were briefly soaked in a mouthwash. New hardness measurements on the same sample now showed a demonstrable hardening of the tooth surface. The advertised effect could actually be detected: toothpastes and dental rinses used in daily oral hygiene indeed offer effective protection of tooth enamel against the damaging influences of acidic foods.

Fig.2: Oral hygiene practices using toothpaste and mouthwash actually do help to protect the enamel.

With the FISCHERSCOPE® HM2000, mechanical properties such as micro-hardness and the modulus of indentation can be determined on tooth enamel in order to draw conclusions on the effectiveness of dentifrices and rinses. For further details please contact your FISCHER representative.