Hope for people with sensitive teeth

An international team of researchers led by Prof. Dr. Katharina Zimmermann has discovered that the cold thermoreceptor TRPC5 causes sensitivity to cold temperatures in teeth. The researchers have published their findings in the renowned scientific journal ‘Science Advances’. ‘Toothache is a nightmare for many people and sensitive teeth can be just as painful,’ says Prof. Dr. Katharina Zimmermann from the Department of Anaesthesiology at Universitätsklinikum Erlangen. ‘People with over-sensitive teeth are all too familiar with the painful sensation they experience as soon as they start eating ice cream.’

Cold thermoreceptor is located directly on odontoblasts

A mechanism in the body that protects human teeth from excess strain is responsible for this. ‘In our teeth, nature has given us the most powerful protective reflex in the body,’ explains Zimmermann, who specialises in pain research. ‘This is because teeth do not heal once they are broken.’ This reflex protects the dental pulp and the sensitive cells of the dental tissue or ondontoblasts. These form the dental hard tissue or the dentine and enamel.

Odontoblasts also function as cold sensors, a fact that the research team have now been able to demonstrate for the first time. The ion channel TRPC5, which functions as a cold thermoreceptor, is located directly on the odontoblastic processes. Ion channels are pores in cell membranes that function like molecular sphincter muscles. After detecting a signal, such as a change in temperature, the channels open and allow ions to flow into the cell. This generates an electrical impulse that is passed on for the purpose of transferring information.

‘The cell bodies of odontoblasts and their nerve endings are located on the outer edge of the dental pulp,’ explains Professor Zimmermann. ‘The odontoblastic processes extend into fine channels in the dentine where they measure the temperature and pass on an electric signal to the brain, which triggers the painful reaction.’

Starting point for toothache medication

Zimmermann has already been involved in research that discovered the cold sensitivity of ion channel TRPC5. ‘We have now found out that the same ion channel is responsible for sensitivity to cold temperatures in teeth. This is an excellent starting point for future toothache medication and protecting teeth that are over-sensitive to cold.’ As the receptor in the tooth is only found on specialised sensory cells and to a lesser extent on nerves, the team at the Department of Anaesthesiology suspects that the usual side effects of nerve block anaesthesia such as numbness and paralysis in the jaw will not occur. The researchers also found an explanation for the mode of action of an ancient household remedy for toothache – the main ingredient of clove oil is eugenol, which blocks the TRPC5 receptor.

Researchers unlock the mechanism behind sensitivity to cold temperatures
The scientists discovered the secret behind the mechanism by conducting experiments on the teeth of mice. The research team developed a new method for registering electrical impulses from the dental nerves of intact mice teeth. ‘By using a special technique with glass electrodes, I was able to compare normal mice with mice that did not have the TRPC5 molecule,’ explains electrophysiologists Dr. Laura Bernal, who now works at Universidad Alcalá in Spain. ‘We discovered that TRPC5 is decisive for a large proportion of the cold responses in teeth and that TRPC5 antagonists block these cold responses.’ In behavioural tests in mice, FAU researcher Dr. Christine König ultimately discovered that the mice that did not have the TRPC5 receptor also did not develop toothache after a tooth infection. This could provide relief to people with teeth that are sensitive to cold temperatures as the team found an especially large number of TRPC5 receptors in infected teeth with tooth decay.

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