

Moving Towards a Better Tomorrow: Backstage Comments of Our Devoted Researchers

The 1913 launch of *Lion Kodomo Hamigaki* marked the **beginning of children's toothpaste** in Japan.

Sometimes, **hundreds of prototypes** are made before a product is finalized.

Lion was the first in Japan to develop **fluoride toothpaste** in 1948.

Eating is living. We **aspire to provide oral care** that does not overlook anyone. I can identify the type of a toothbrush by touch, even with my eyes closed.

We aim to transform teeth-brushing from a **“must-do”** to a **“want to-do”** activity.

Maintaining oral health so people can make every day a healthy one

We visit **mint farms annually** to select the ideal natural mint oil for our toothpaste.

We strive for a **quality** that I can **confidently recommend** to my family.

I have developed a **habit of noticing people's teeth** when I meet them for the first time.

Lion R&D **relentlessly and sincerely** delves into various fields, including dental caries and gum disease.

We were praised by a leading expert who was **surprised and impressed** by our research presentation on bad breath. We evaluate performance under extreme conditions, like **below freezing or at 40°C**, to ensure reliability anywhere.

Lion R&D will continue to explore new frontiers

LION SCIENCE JOURNAL



Starting with oral health, we envision a world where everyone is healthy.

At Lion, we have been committed to oral health since our founding. In addition to offering products, we have been disseminating information about oral health and raising awareness among the public, encouraging people to adopt better habits.

Moving forward, we aim to bring together all the touchpoints related to oral health, looking beyond families to include dental clinics, corporations, schools, local governments and communities. We aim to further encourage people to create proactive and preventive dental care habits that are tailored to their lifestyles, as well as their physical and mental health. With this in mind, we are excited to help people improve their overall health.

The History of Lion's Oral Care Promotional and Educational Activities

1913



Held the First Lion Oral Hygiene Lecture
The start of our promotional and educational activities

1921



Opened the Lion Dental Clinic for Children
Japan's first dental clinic for children

1932



Held the First Oral Health Event of Tooth Brushing for Children
Teaching correct tooth brushing methods to children

1952



Introduced the Lion Health Car
A mobile clinic that toured nationwide

1961



Held the First Cherry Movement
Japan's first initiative to promote oral health at workplaces

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For more information about Lion's research and development, please visit our website.

<https://www.lion.co.jp/en/rd/>



Total Body Health Begins with Oral Care

Oral Healthcare: The Foundation of Vitality

The relationship between oral health and healthy life expectancy is becoming increasingly clear. Since 2017, the government's Basic Policy on Economic and Fiscal Management and Reform (commonly known as the Basic Policy) has put priority on the enhancement of oral health, along with the building and strengthening of the dental healthcare system.

Moreover, the Healthy Life Expectancy Extension Plan, formulated in 2019, includes measures for reinforcing efforts to fight gum diseases, indicating that oral care is seen as one of the critical elements in extending people's healthy life expectancy.

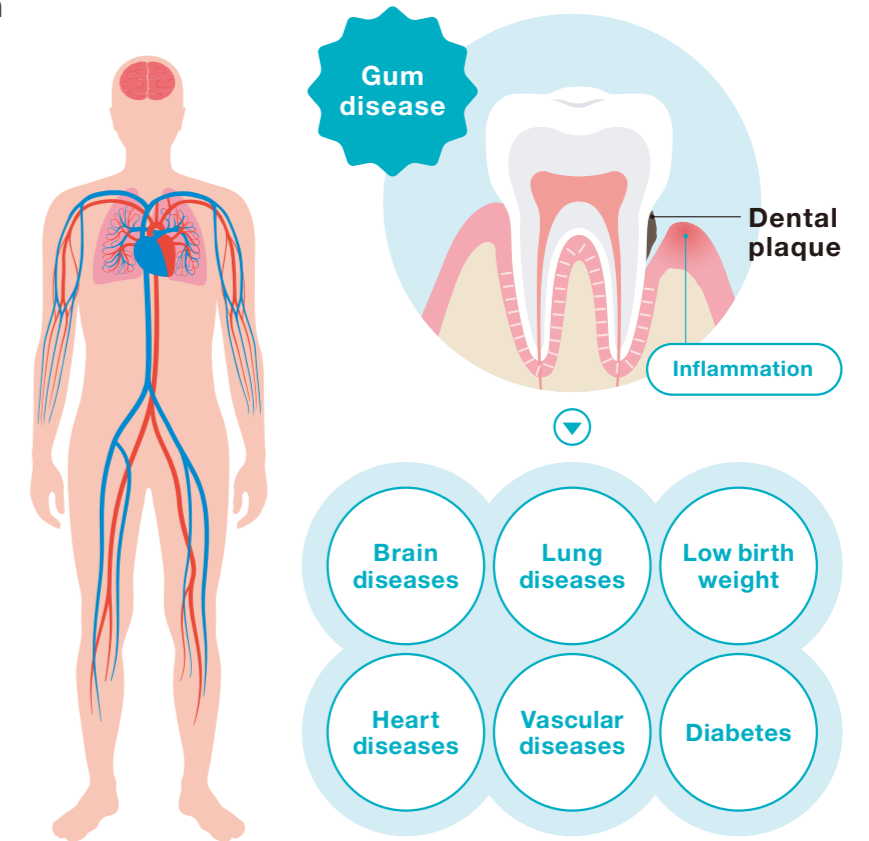
We believe that oral care habits not only contribute to dental health and, by extension, overall physical health, but also foster children's sense of autonomy and positively influence interpersonal relationships.

Based on this, we define oral Healthcare as a habit that forms the foundation of vitality—comfortably eating, talking, laughing, and remaining true to oneself throughout life. We aim to transform oral science research into innovative products and services, promoting positive preventive dental habits.

The Relationship Between Oral Health and Overall Health

Since 1989, the Ministry of Health (currently the Ministry of Health, Labour and Welfare) and the Japan Dental Association have been promoting the 8020 (Eighty-Two) Campaign, which aims for people to keep at least 20 natural teeth at the age of 80. Preserving teeth is considered important not only from a nutritional intake perspective, but also because teeth play a significant role in oral functions, such as chewing and pronunciation, which are important for daily pleasures like eating and conversing. Various studies have investigated the relationship between oral health and healthy life expectancy, indicating that people with more natural teeth tend to have a longer healthy life expectancy, and that higher chewing ability correlates with better quality of life (QOL). Additionally, research has shown that neglecting tooth loss increases the risk of developing dementia.

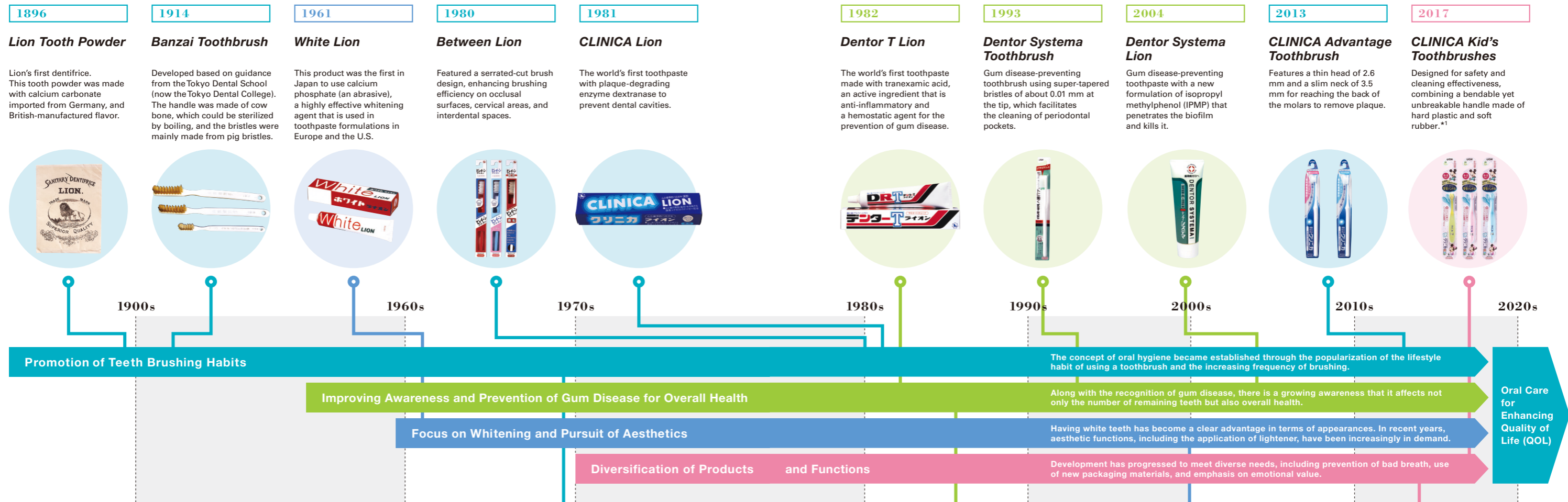
Studies over the past few years have linked gum disease to various illnesses, and research institutions around the world are working to unravel its mechanisms. Maintaining oral health is crucial for a better daily life.



Lion's Oral Care Products Contribute to Healthy Life Expectancy

The current era increasingly seeks ways to prolong a "healthy and happy life." Today, Lion continues to evolve, utilizing its expertise in oral health spanning nearly 130 years to aim for oral healthcare that helps extend healthy life expectancy.

Evolving Consciousness of Oral Hygiene and Evolving Products



Distinctive Toothbrushes

1951
Nylon Bristle Lion Toothbrush

In an era dominated by animal bristles, this was the first toothbrush to adopt DuPont nylon bristles. The bristles were rounded at the tips to improve the brushing experience.



1969
Banet Lion

Designed with an arch-shaped handle based on ergonomics to effectively brush the backside of teeth.



2009
Dentor Systema Sonic Assist Toothbrush*2

Featuring a lightweight, slim handle and a compact head for easy handling similar to regular toothbrushes. It combines sonic vibration with uniquely double-height tufting using tapered, multi-level bristles for effective plaque removal.



2019
CLINICA Advantage NEXT STAGE Toothbrush*3

This toothbrush notifies people with a click sound when they are applying excessive force during brushing, preventing overly aggressive brushing that can cause gum recession.



Cavity Prevention

1948
Lion F Cream
Japan's first toothpaste containing fluoride. It was a forerunner in products that focus on functionality.



2009
CLINICA Advantage Toothpaste
Features a total care formula for preventive dentistry, enhancing fluoride retention with cationic cellulose that adheres well to tooth surfaces. In March 2017, following the approval of toothpaste formulations with a maximum fluoride content of 1,500 ppm, as per international standards (ISO), its fluoride content was increased to 1,450 ppm.



Gum Disease Prevention

1964
Dentor Lion
An alveolar pyorrhea (gum disease) preventing toothpaste that raised awareness about the disease with the ad copy, "Do you bleed when you bite into an apple?"



1993
Dentor Systema Lion Series
A series that specializes in preventing gum disease. This three-piece set consisted of a toothbrush with super-tapered bristles for reaching periodontal pockets, a liquid toothpaste that easily penetrates periodontal pockets, and a mouthwash with high-retention antibacterial ingredients.



Whitening Functions

2001
White & White Prime Lion
Pioneering whitening toothpaste with an enhanced whitening function using polyphosphate for chemical stain removal.



2021
Lightee
Whitening toothpaste that removes stains lodged in micro-scratches and reflects light for brighter, whiter teeth.



Preventing Bad Breath

1968
Etiquette Lion
Addresses causes of bad breath through a combination of cleaning and foaming agents, and also contains unique fragrances for a lasting refreshing feeling.



2017
NONIO
Features a unique long-lasting sterilization system that intensively targets the sources of physiological bad breath.



*1 Suitable for ages 0-2 and 3-5. *2 In April 2023, LION Electric Assist Toothbrush was launched, offering replaceable brushes to suit different oral needs. *3 In July 2022, renamed to CLINICA PRO Toothbrush.

Lion's Oral Science Research Supports People's Health

Lion has long been advancing research and development for maintaining and improving oral health. Utilizing technology, we conduct research on oral tissues and oral microbiome, and develop oral care products and services tailored to each individual's oral condition and habits. Through this, we promote the establishment of preventive dentistry habits and support people's health.

Acquiring the habit of preventive dentistry from a young age is essential for maintaining healthy teeth throughout life. We aim to make tooth brushing a fun habit and turn the time parents and children spend brushing their teeth together into valuable bonding time. To achieve this, we are focusing on product development with more emphasis on product safety and creating flavors that infants and young children will like.

Moreover, it is said that the mouths of newborn babies do not have the pathogenic bacteria associated with cavities or gum disease. However, as babies grow surrounded by family members, various bacteria settle in their mouths and form microbiota.

We believe that fostering a healthy microbiota is important for maintaining good oral health, and our research is focused on the microbiome.



This period, known as the mixed dentition phase, is marked by the transition from baby teeth to permanent teeth. The coexistence of baby teeth and permanent teeth often results in uneven tooth heights and misalignments, making brushing difficult. Moreover, the enamel of newly emerged permanent teeth is still immature, making the surface of the teeth rough and more susceptible to stains. These teeth are also more vulnerable to acids produced by cariogenic bacteria, increasing the risk of dental caries.

We are developing products tailored to the unique mouth conditions of this growth stage, enabling children to brush their teeth effectively on their own.

The period from infancy to adolescence is also a crucial time for acquiring oral functions. At Lion, we are advancing research aimed at oral function acquisition that facilitates a foundation for proper teeth alignment.

Excluding wisdom teeth, a person usually has 28 permanent teeth. If more than 20 teeth can be retained, people can more or less satisfactorily chew hard foods. In Japan, the government has promoted the 8020 Campaign (where people aim to retain at least 20 teeth at the age of 80) since 1989, and teeth retention has been improving over the years.

The risk of oral diseases and tooth loss in the elderly increases due to the accumulation of plaque over the years, exposure of tooth roots due to aging, and changes in the oral environment, such as dry mouth or

the use of dentures. Lion is advancing the development of oral care products tailored to the oral conditions of seniors to reduce these risks.

Furthermore, in addition to dental caries and gum disease, the decline in oral functions can impact quality of life (QOL) in activities like eating, talking, and laughing. To maintain and improve QOL over one's life, we are not only focusing on oral hygiene but also carrying out research on ways to prevent oral frailty.

The decline in gum health actually begins in one's 20s and 30s, and is not a problem limited to middle-aged and older adults. In pursuit of establishing preventive dentistry habits, we have developed oral care products that effectively remove plaque that accumulates at the gum line. Additionally, through the development of products that offer whitening and bad breath prevention, we support the positive aspects of communication, like talking and laughing.

Furthermore, women during pregnancy and after childbirth are prone to deterioration in oral environment

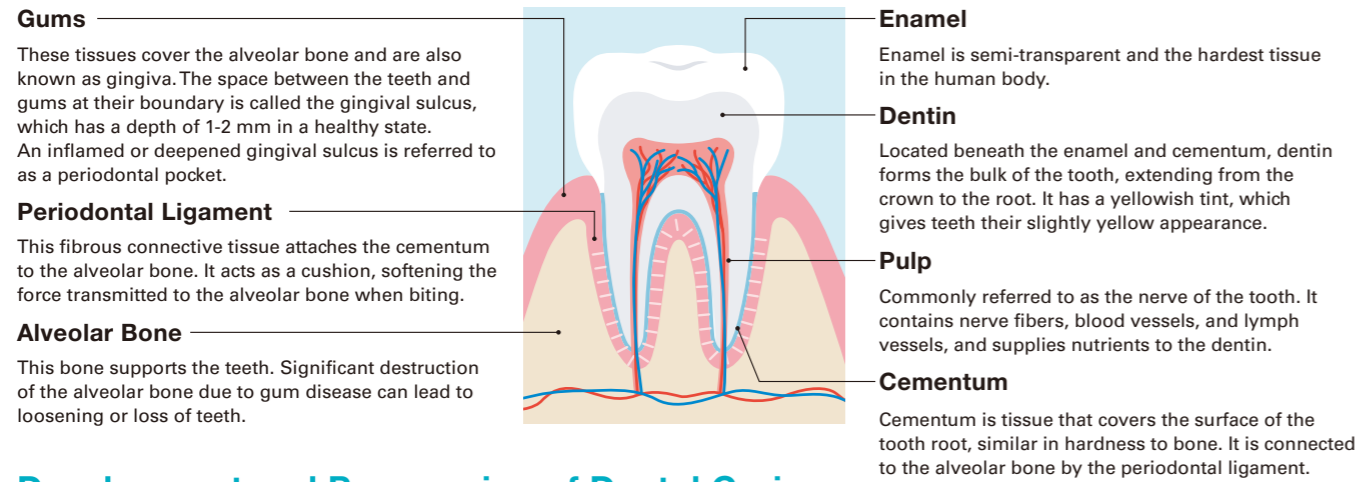
due to morning sickness and hormonal changes. For this reason, Lion is also developing products that maintain oral cavity hygiene effortlessly, even when oral care cannot be adequately performed due to morning sickness or being too busy.

We will continue our research from multiple perspectives, targeting various life stages, living environments and oral conditions, so that everyone has choices for their optimal care products and can continue to take care of themselves with comfort.

Basic Knowledge of Teeth

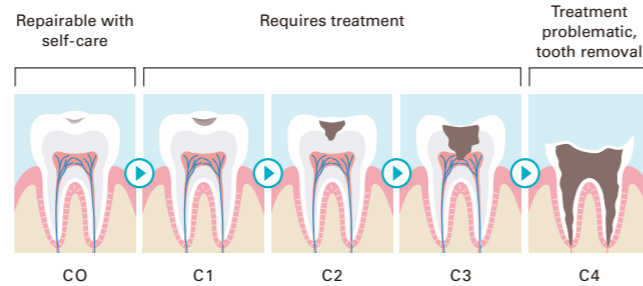
Structure of Teeth and Periodontal Tissue

Teeth are composed of enamel, dentin, cementum and pulp. The part exposed above the gum line is called the crown, while the part covered by gums is known as the root. Teeth are supported by periodontal tissues, including the alveolar bone, gums and periodontal ligament.



Development and Progression of Dental Caries

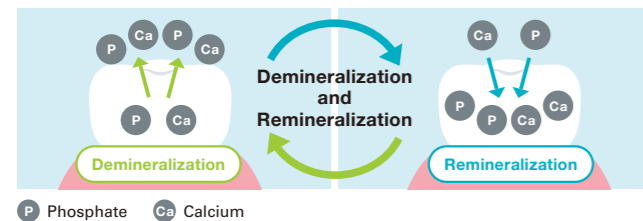
Dental caries occur and progress over time due to the combination of three elements: "causative bacteria," "carbohydrates," and "teeth susceptible to acid." Mutans streptococci, a major caries-causing bacteria, produce a sticky substance called glucan from carbohydrates. This glucan adheres to the teeth, facilitating the attachment and proliferation of various bacteria, leading to the formation of dental plaque. They also produce acid from sugars, and when the pH level on the tooth surface drops below 5.5, minerals like calcium and phosphorus from the enamel dissolve (a process known as demineralization), furthering the progression of caries.



Stages of Caries Progression (C0 - C4)

At the initial stage of dental caries (C0), the enamel begins to dissolve, causing it to lose its luster. No holes are present in the tooth, and there are no symptoms like pain. This early stage of caries can be restored to a healthy state through "remineralization."

As the process of demineralization progresses further, holes start to form in the enamel (C1), necessitating treatment. When the caries reach the dentin (C2), pain is experienced. At C3, where the caries reach the pulp, intense pain is felt. As the condition advances and nearly the entire crown is destroyed, leaving only the tooth root (C4), the pulp dies, and pain is almost no longer felt.



Development and Progression of Gum Disease

Gum disease is a condition where inflammation in the periodontal tissues occurs due to toxins released by periodontal pathogens accumulated in the gingival sulcus. It often progresses with minimal pain or other symptoms, making it difficult to notice until it has advanced significantly. To prevent the occurrence and progression of gum disease, it is important to 1 carefully brush one's teeth every day, 2 check one's own teeth to discover any issues at an early stage, 3 have regular dental checkups, and 4 maintain a regular diet that enhances the function of the body's immune system.



Gingivitis

A condition where inflammation is confined to the gums, and with appropriate care, it is possible to return to a healthy state.

Periodontitis

As inflammation spreads, the gingival sulcus deepens beyond 4 mm, reaching the alveolar bone, causing tooth loosening and distinctive bad breath.

Mechanism Discovery to Studying Actual Conditions:

Unraveling Oral Healthcare with Research Data

Since its foundation, Lion has always prioritized the health of people as it continues its pursuit of oral health. Leveraging 130 years of knowledge, Lion is contributing to the establishment of positive habits in preventive dentistry.

DENTAL CARIES

Fluoride Retention, Removing Dental Plaque

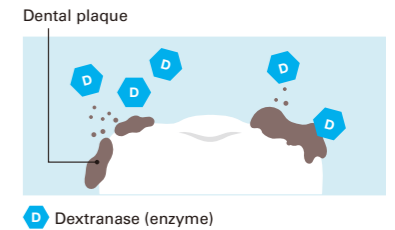
Pursuing advanced Dental Caries Prevention Functions

Dental caries prevention fundamentally involves removing plaque, building strong teeth that can withstand the acid produced by bacteria, and being mindful of one's diet, especially intake of free sugars.

At Lion, we are focused on further enhancing the dental caries prevention function of daily toothbrushing. We pursue this through the use of the plaque-degrading enzyme dextranase and the development of oral fluoride retention technology.

Development of World's First Toothpaste with Plaque-Degrading Enzyme Dextranase

Dental plaque has typically been physically removed using toothbrushes. However, Lion has focused on dextranase, an enzyme that acts on glucan produced by bacteria, to dissolve and remove plaque. Overcoming challenges such as decreased enzyme activity due to interaction with other ingredients in the toothpaste, after a development period of 15 years, we successfully commercialized the world's first toothpaste containing dextranase in 1981. To this day, we remain the only seller in Japan of toothpaste containing this enzyme.



Three Functions of Fluoride

Fluoride has the following three main functions:

1 Promoting Remineralization:

Fluoride promotes the redeposition (remineralization) of calcium and phosphate that have dissolved from the teeth (repairing incipient caries).

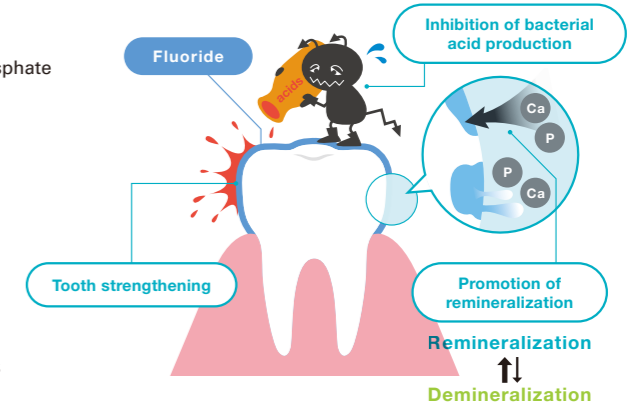
2 Strengthening Teeth:

Fluoride strengthens teeth, making them more resistant to acid.

3 Inhibiting Bacterial Acid Production:

Fluoride weakens the activity of cariogenic bacteria in dental plaque, suppressing the production of acid.

Functions of fluoride

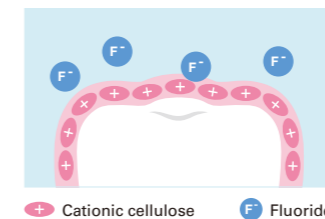


After brushing, fluoride remains on the teeth and oral mucosa, gradually mixing with saliva and exerting its effects inside the mouth. It is therefore crucial to keep fluoride in the oral cavity for an extended period.

Lion's Unique Fluoride Retention Technology

Cationic Cellulose

Lion has verified that the use of cationic cellulose in toothpaste increases the amount of fluoride retained on the tooth surface.*1 This ingredient, which easily adheres to the tooth surface, coats it and attracts fluoride through electrostatic interaction, thereby retaining fluoride for a longer period.



Lion's Unique Fluoride Retention Technology

Pyrrolidone Carboxylic Acid

Root caries, which occur on the exposed root surfaces of teeth due to gum recession associated with aging, are also referred to as adult caries and are thought to play a large role in the caries prevalence rate in the elderly. The root of a tooth is not covered by enamel and is primarily composed of dentin, making it more susceptible to caries. Our extensive research has found that pyrrolidone carboxylic acid coats the exposed collagen of root dentin, enhances fluoride retention in the dentin, and inhibits demineralization.*2

*1 Kubota et al., Journal of Dental Health, 55(4), p384 (2005)

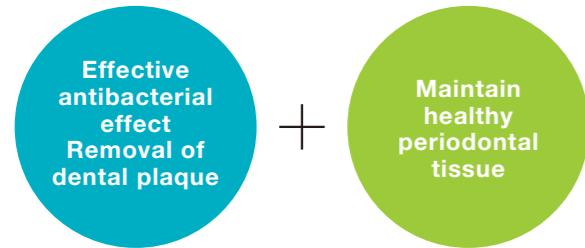
*2 Ishii et al., The Japanese Journal of Conservative Dentistry, 62(6), p286-295 (2019)

GUM DISEASE

Approaching Gum Disease from Both a Pathogen and Host Periodontal Tissue Perspective

Aiming for Zero Gum Disease with Antibacterial Effects and Host Tissue Care

Key Points for Self-Care of Gum Disease



Gum disease is a condition where inflammation occurs in the periodontal tissues, such as the gums and the alveolar bone, which support the teeth. This is due to infection by periodontal bacteria in the plaque at the gum line.

To prevent gum disease, it is important to simultaneously carry out two approaches: reducing periodontal bacteria through thorough removal of dental plaque and antibacterial reaction (the bacteria approach), and stimulating periodontal tissues to maintain healthy gums (the periodontal tissue approach). Lion is advancing research aimed at preventing gum disease by approaching both periodontal bacteria and periodontal tissue.

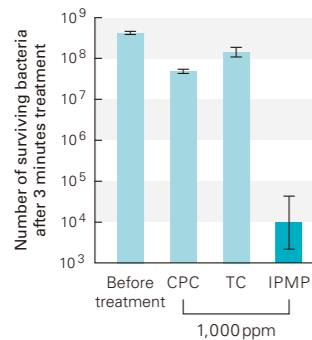
Periodontal Bacteria Approach

IPMP Penetrates the Biofilm to Exert Antibacterial Effects

Dental plaque is a biofilm composed of multiple types of bacteria, where periodontal pathogenic bacteria resides. Removing plaque requires physical efforts such as brushing. Furthermore, since these bacteria form clusters inside the biofilm, it is difficult for antibacterial agents to reach and kill the bacteria inside.

To find a drug that can penetrate and kill bacteria within the biofilm, we developed an artificial oral biofilm and screened a variety of active ingredients. We discovered that isopropyl methylphenol (IPMP), an antibacterial agent used in antiperspirants, deodorants, and hand soaps, has the ability to penetrate and kill bacteria within the biofilm.*

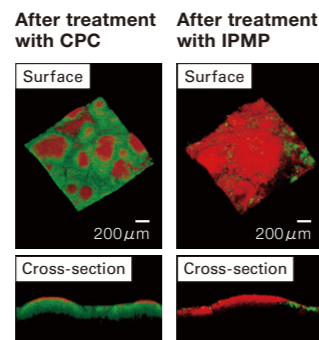
Bactericidal Effect of Antibacterial Reagents on Oral Biofilm



IPMP : Isopropyl methylphenol
TC : Triclosan
CPC : Cetylpyridinium chloride

* Morishima et al., Journal of Dental Health, 54(4), p437 (2004)

Penetration and Bactericidal Effect of IPMP on Human Oral Biofilm



In situ dental plaque formed after 6 days of wear
Drug concentration: 1,000 ppm, 3- minute treatment
Green indicates live bacteria, red indicates dead bacteria

For more details, click here.



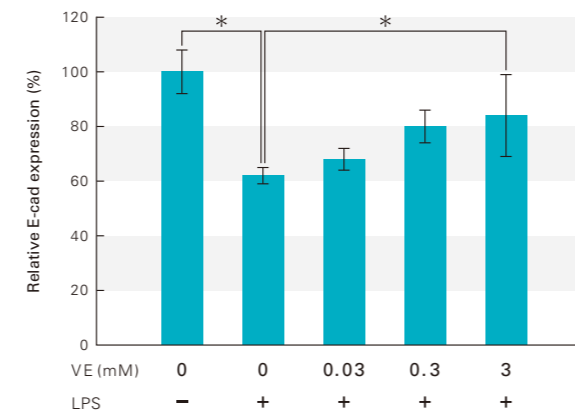
Periodontal Tissue Approach

Vitamin E Strengthens Gum Resistance!

Gingival epithelial cells, located in the outermost layer of the periodontal tissue, are known to function as a physical barrier against attacks by periodontal bacteria, that could cause gum disease.

Lion has discovered that Vitamin E (VE), which is effective in promoting blood circulation in the gums, inhibits reductions in the expression of E-cadherin (E-cad), one of the cell adhesion factors that connect gingival epithelial cells. In other words, VE strengthens the bonds between gum cells and prevents the invasion of periodontal bacteria into the gums, thereby playing a role in the prevention of gum disease.

Impact of VE on E-cad expression*



* p < 0.05; by Steel's test LPS: Lipopolysaccharide, a component of periodontal bacteria

* Reference: Yutori et al., J Periodont Res., 52, p42-50 (2017) Fig. 2

For other related research, click here.



ORAL FUNCTION

Supporting Overall Health and Better Quality of Life, Starting from the Mouth

Oral Function Research to Preserve 'Eating, Talking, and Laughing'

For Health, Fitness Begins with the Mouth!

The activities of eating, talking, and laughing are key aspects of quality of life (QOL). Weakening of perioral muscle due to aging can cause problems such as choking, dry mouth, as well as difficulties in speaking, chewing, and swallowing, potentially leading to a decline in physical and mental functions. Therefore, early intervention is essential for optimizing QOL.

Lion has developed a service for training the perioral muscles in order to maintain and improve oral functions. We conducted validation of its effectiveness, confirming that approximately two months of training improved the participants' saliva secretion and their tongue motor function. We will continue to support people's health by developing useful services based on our knowledge gained from oral science research.

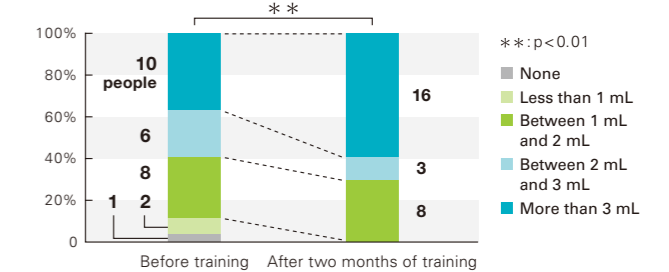
Research Achievement

Aoyama et al., The 34th Annual Meeting of the Japanese Society of Gerodontology "Validation of the usefulness of ORAL FIT, an oral frailty management service: A Pilot Study" (2023)

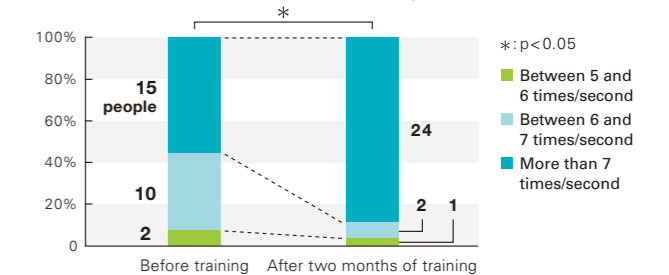
For more details, click here. (Japanese)



Saliva secretion (amount of saliva secreted during 5 minutes of rest)

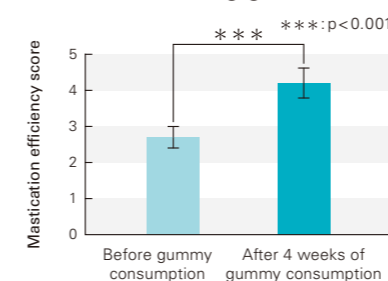


Tongue motor function (speed of repetitively pronouncing /ka/ for 10 seconds)



Nurturing Chewing Strength and Laying Foundations for Good Teeth Alignment

Changes in masticatory performance before and after consuming gummies we developed



Research Achievement

Sato et al., 61st Annual Congress of the Japanese Society of Pediatric Dentistry "Effect of Hard Gummy Chewing on Oral Function in Elementary School Children" (2023)

For more details, click here. (Japanese)



The school-age period is a time of significant development in oral function, where proper development is crucial for forming occlusion and teeth alignment. In particular, thorough chewing nurtures chewing strength through the use of various muscles around the mouth, promotes jaw development, and contributes to laying the foundation for good teeth alignment.

To improve chewing strength, Lion has developed gummies with moderate elasticity and hardness, sized to be chewed evenly with teeth on both sides of the mouth. After 4 weeks of daily consumption, improvements were observed in masticatory performance (the ability to bite, crush, and mix food), lip closure strength (the ability to close the mouth), and bite force (the strength to bite down with back teeth).

COLUMN

Impact of Posture and Mouth Breathing on Teeth Alignment

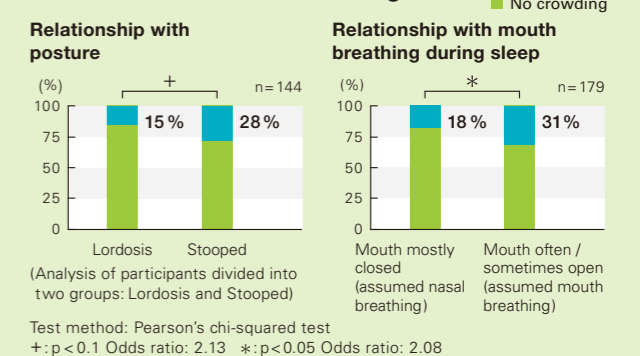
It has been suggested that deterioration in dental arches and occlusion is linked to lifestyle habits and daily routines, but scientific evidence has been insufficient to back up this theory. To clarify the relationship between teeth alignment and lifestyle habits/posture, a study was conducted* on elementary school children who are experiencing permanent teeth development. The three-year-long study revealed that children with a stooped posture or who often sleep with their mouth open tend to have a higher incidence of crowding (a condition where teeth partially overlap). More research needs to be conducted in order to establish a causal relationship.

* Conducted in collaboration with Kuroishi City and Hirosaki University

For more details, click here.



Relationship Between Crowding and Posture/Mouth Breathing



Test method: Pearson's chi-squared test
+ : p < 0.1 Odds ratio: 2.13 * : p < 0.05 Odds ratio: 2.08

ORAL MICROBIOME

Is Oral Health Determined by Early Childhood Environment?

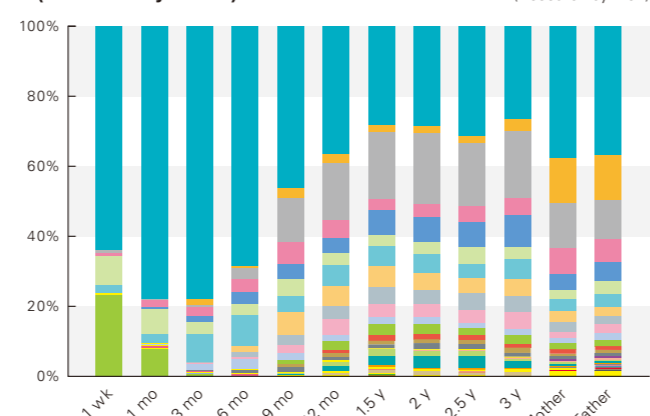
Importance of Oral Care in Early Childhood Revealed through Microbiota Analysis

Microbiota Analysis Using Next-Generation Sequencer

Dental caries and gum disease are infections caused by bacteria lurking in plaque. It is now known that some oral bacteria, such as those that cause dental caries, can be transmitted from parents to their children. From the perspective of dental caries prevention, it is currently recommended to avoid practices like sharing chewed food or utensils with children.

The human oral cavity is inhabited by various types of bacteria, collectively referred to as microbiota. The influence of parents' oral microbiota on the formation of their children's oral microbiota remains largely unexplored. To understand the formation of microbiota in early childhood, a cohort study using next-generation sequencing techniques was conducted to track the changes in the microbiota from one week after birth to the age of three.

Changes in Composition of Oral Microbiota (Classified by Genus)*



* This shows changes in average composition of oral microbiota for approximately 50 participants for which data was obtainable. The color coding shows the ratio of existing bacteria in the same genus.

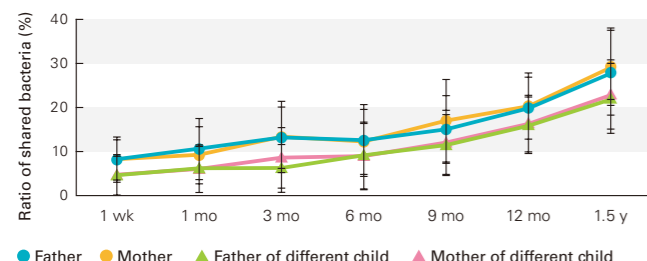
Parents' Oral Microbiota Influence Formation of Infants' Microbiota

The study revealed that at one week after birth, dozens of bacterial species were present in the oral cavity. Over time, the variety of bacteria increased, approaching the number detected in parents. The study also found that the ratio of shared oral bacteria between parents and children was significantly higher than between

unrelated parents and children. At around six months after birth, the detection ratio of oral bacteria commonly found in adults started to increase, and reached about 75% by one and a half years of age. This includes *Fusobacterium nucleatum*, an anaerobic oral bacterium related to bad breath and gum disease.

This suggests that the development the microbiota is influenced not only by parents, but also by other people who spend time with the infant. Early oral care for children, along with surrounding adults maintaining a healthy mouth, is thought to reduce the risk of oral diseases in children. Further research on oral microbiota will shed more light on the role of bacteria in oral diseases and inform our product development.

Changes in Ratio of Shared Oral Bacteria Between Parents and Children*



* The oral bacteria of the parents were analyzed using saliva samples taken when their child was 1.5 years of age.

Research Achievements

Jo et al., The Japanese Journal of Pediatric Dentistry, 57(2):228 "Comparison of Oral Bacterial Profile between Parents and Child from Birth to 18 Months" (2019) / Yama et al., 63rd Annual Meeting of Japanese Association for Oral Biology "Trajectories of high prevalent oral bacteria during the first 36 months of life using next-generation sequencer" (2021)



For more details, click here.



- *1 Ishizuka et al., 51st Annual Meeting of Japan Society of Health Evaluation and Promotion "The Relationship Between the Oral Environment and General Health through the Introduction of Dental Checkups" (2023)
- *2 Gum health as measured by white blood cell count.
- *3 Overall health indicators measured by CRP (a protein released into the blood in reaction to inflammation) and HbA1c (ratio of glycosylated hemoglobin in red blood cells, used to diagnose diabetes) values.

WHITENING

Lifting and Removing Stains

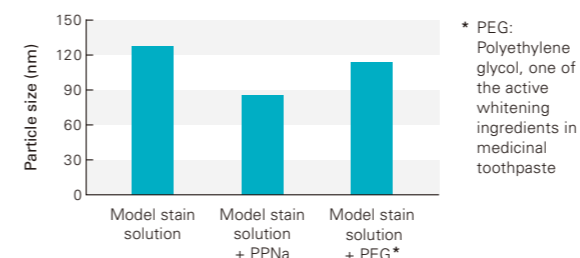
Whiter Teeth with Sodium Pyrophosphate

Exogenous tooth discoloration (stains) can be removed through physical action with daily toothbrushing, and also chemical action. Lion has focused on enhancing stain removal by examining the action mechanism of condensed phosphates (chemical stain removers), specifically sodium pyrophosphate (PPNa).

When PPNa was applied to a model stain we created, it resulted in smaller particle sizes of stain aggregates and an increase in the thickness of the stain film (swelling). Based on these results, it seems that PPNa, through chelation, decomposes and swells stains, making them easier to remove when physical force is applied.

Furthermore, the potential for enhanced stain removal was also observed when used in combination with sodium lauryl sulfate, a widely used foaming agent.

Evaluation of Particle Size of Stain Aggregates

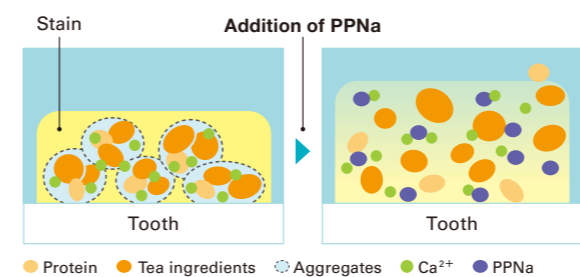


* PEG: Polyethylene glycol, one of the active whitening ingredients in medicinal toothpaste

Research Achievement

Hashimoto, et al., The 31st Annual Meeting of Japan Academy of Esthetic Dentistry "Study of the mechanism of stain removal by the effect of sodium pyrophosphate" (2020)

Consideration of Stain Removal Mechanism



COLUMN

Accelerating Product Development with AI

Application of Digital Technology in Research & Development

The product development process entails combining various ingredients in numerous ways and putting it through

various evaluations to find the optimal combination. Traditionally, this process was based on the experience of researchers. Today, however, our toothbrush development process combines the experience and knowledge of researchers with informatics technologies, like AI and machine learning. Using this approach, we aim to shorten the evaluation period and accelerate the development process.



For more details, click here.

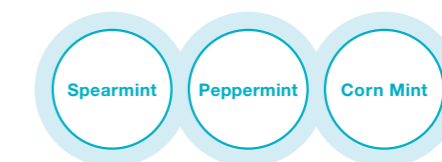


MINT

Brushing Becomes Fun

Sweetness of Natural Mint

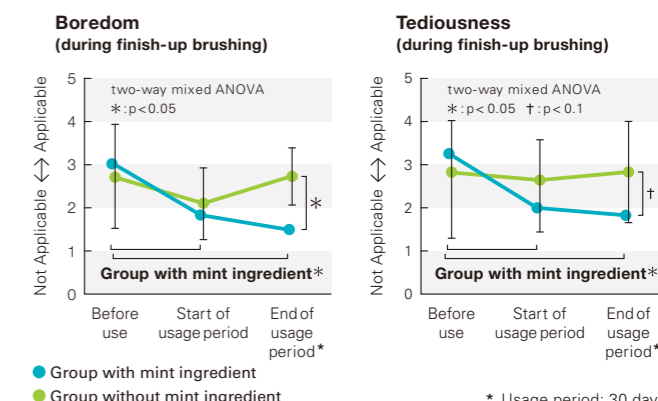
Using natural mint, known for its unique sweetness and refreshing sensation, is one way that Lion takes a unique approach in flavor development. As the quality of mint varies depending on the variety, origin, and even weather conditions that year, our researchers visit the production areas every year to select the best natural mint oil, ensuring a consistent flavor experience for our customers.



For more details, click here.



The Effects of Toothpaste Flavor on Toothbrushing Behavior of Young Children



We have focused on the sweetness of natural mint and found that incorporating a unique ingredient derived from natural mint into fruit-flavored toothpaste results in a long-lasting sweetness. We tested the effect of the flavor of children's toothpaste on the toothbrushing behavior of young children. The results showed that the children's feelings of boredom and tediousness improved during finish-up brushing by their parents.

Research Achievement

Ohki, et al., 56th Annual Meeting of the Japanese Association for the Study of Taste and Smell "The effect of the flavor of children's toothpaste on the toothbrushing behavior of pre-school children" (2022)

For more details, click here. (Japanese)



COLUMN

Investigating Impact of Dental Checkups on Oral and Overall Health

In collaboration with the Hitachi Health Care Center of Hitachi, Ltd., Lion conducted a study on the effectiveness of dental checkups at the workplace.*¹ Following approximately four years post-implementation of dental checkups, the

results of this study showed an increase in the frequency of oral care practices among employees over time and improvement in their oral health. Furthermore, in the group where gum health improved,² there was a meaningful reduction in deterioration of overall health indicators,³ compared to the group without gum health improvement. Understanding one's oral health status through dental checkups can lead to better oral care habits and improved oral health, which may also be linked to better overall health.



For more details, click here.



- *1 Ishizuka et al., 51st Annual Meeting of Japan Society of Health Evaluation and Promotion "The Relationship Between the Oral Environment and General Health through the Introduction of Dental Checkups" (2023)
- *2 Gum health as measured by white blood cell count.
- *3 Overall health indicators measured by CRP (a protein released into the blood in reaction to inflammation) and HbA1c (ratio of glycosylated hemoglobin in red blood cells, used to diagnose diabetes) values.

Secrets Behind Toothbrush Development

Key Functions of a Toothbrush are Plaque Removal and Massage

A toothbrush serves two critical functions: removing plaque through physical action and massaging the gums. However, each person has different teeth alignment, tooth size, gum health, and intraoral shape, which leads to diverse preferences for functionality, comfort, and brushing method. To meet these diverse needs, we meticulously design each part of the toothbrush, guiding it to its optimal specification.

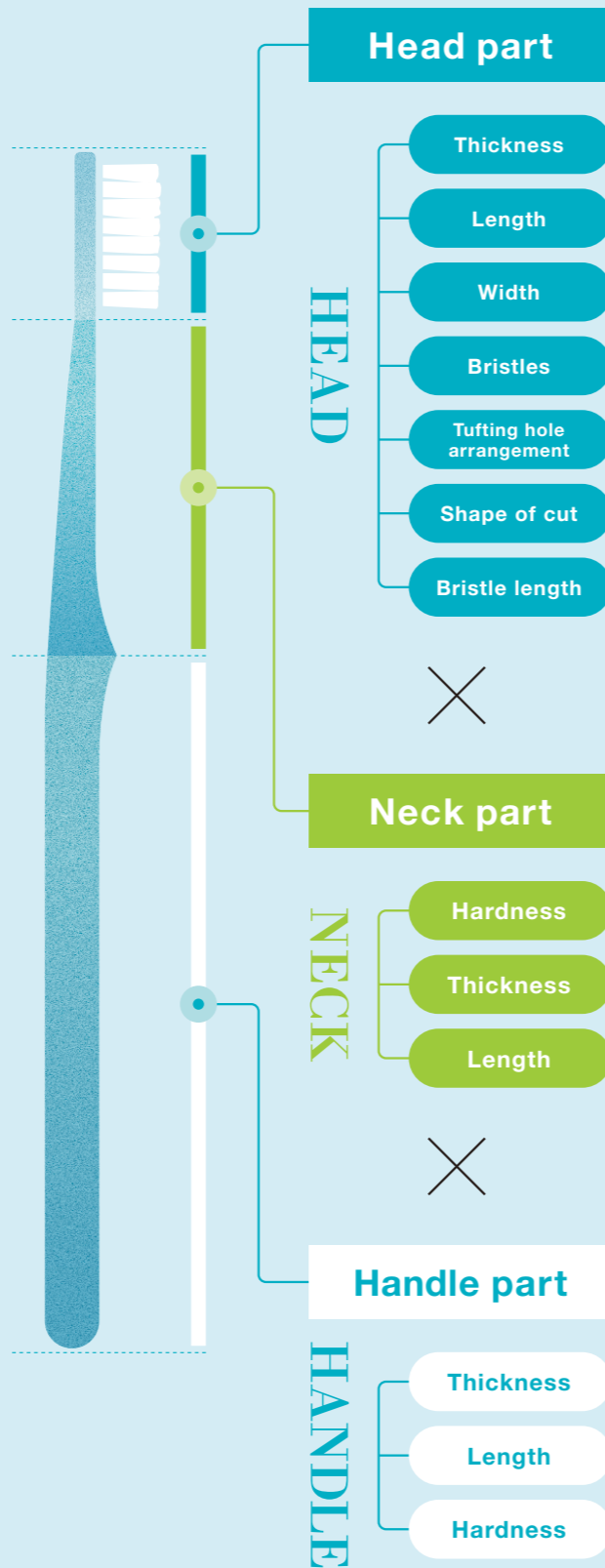
Design Points for Toothbrushes

Plaque Removal

- 1 Plaque on Tooth Surfaces** Using straight bristles of uniform thickness from the base to the tip, which have firm elasticity, minimizes bristle deformation during toothbrushing and enhances the plaque-removal effectiveness.
- 2 Plaque in Gaps** To remove plaque in narrow spaces like between teeth, gum line, and gingival sulcus, ultra-fine super-tapered bristles, which become thinner towards the tips, are used to increase the reach of bristle tips into these areas.
- 3 Plaque on Molars** Molars, being hard to reach with a toothbrush, are at higher risk for dental caries and gum disease. Thinning head and slimming neck of the brush ensure it reaches the back (distal surface) of the last molars, facilitating the efficient removal of plaque.
- 4 Plaque on Uneven Surfaces** Areas where teeth are uneven in height or alignment are prone to brushing neglect, increasing the risk of dental caries and gum disease. Using bristles cut in a mountain or dome shape, or mixing different cut shapes, enhances a toothbrush's reach to these uneven surfaces.

Gum Massage

- 5 Promotion of Blood Circulation** Massaging the gums to promote blood circulation helps normalize the turnover of periodontal tissues. Soft, elastic, and super-tapered bristles create high-density bundles that are tufted into the toothbrush with consideration for their fit to the gums. This design allows for a comfortable and effective massage.



Did you know that the toothbrush you use every day is intricately designed for a specific purpose? Lion was the first company in Japan to include "toothbrush" in a product name, and has never stopped promoting toothbrushing as a healthy habit. Lion is committed to creating the best toothbrushes, and continues to pursue greater functionality and effectiveness. Next, we delve into the amazing world of toothbrushes.

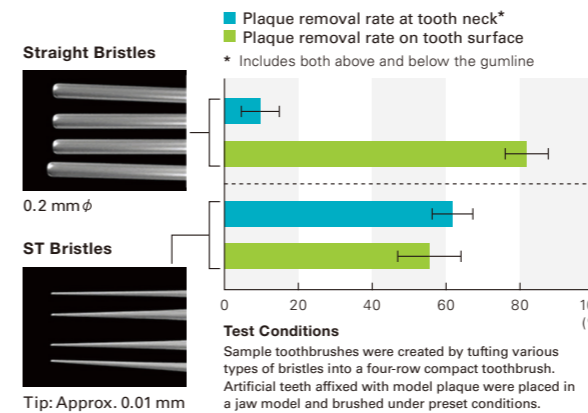
POINT 1 Differentiation in Bristle Usage

Bristles can be broadly divided into two types based on their shape: straight and supertapered (ST). Straight bristles are highly effective in removing plaque from broader surfaces, while ST bristles are suitable for cleaning narrow gaps. The cleaning ability and feel also vary depending on the thickness and length of the bristles, the arrangement of the bristle bundles, and the size of the head part.

For more details, click here.



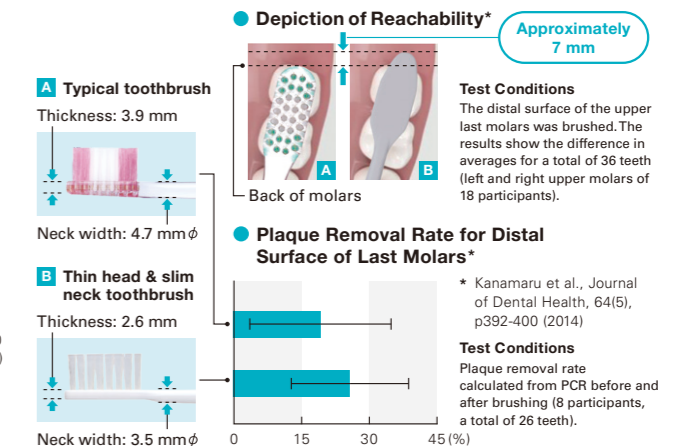
Cleaning Efficacy of Straight and ST Bristles



POINT 2 Thin Head and Slim Neck Design

A toothbrush with a thin head and a slim neck ensures good maneuverability inside the mouth and effective brushing of the back molars. However, this design also presents challenges in terms of bristle shedding and strength. To address these issues, we reassessed the material of the toothbrush and adopted "polyacetal," a high-strength plastic. Molding the toothbrush under optimal conditions ensures sufficient strength.

For more details, click here.

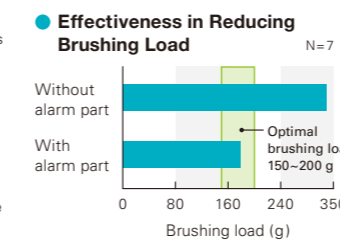


POINT 3 Handle Design with Sound-Generating Structure

Excessive force during brushing can lead to gum recession and increased risk of root caries. Lion has therefore developed a toothbrush that takes advantage of the "snap-through buckling" mechanism.* This design emits a clicking sound when excessive force is applied during brushing, alerting the brusher.



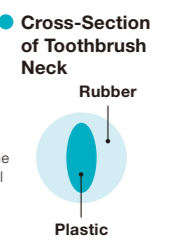
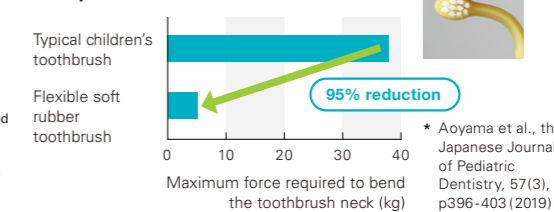
* Snap-through buckling: This phenomenon occurs when an object, initially in a stable energy state, undergoes a sudden transition to a second stable energy state once a threshold variable load is exceeded. Common examples include the lid of an oil can or snap-type hairpins.



POINT 4 Flexible Soft Rubber Toothbrushes

To reduce the risk of injury to a child in case they fall with a toothbrush in their mouth, Lion developed a toothbrush with a flexible yet unbreakable neck. Soft rubber is used as the main material, and the minimal required amount of oval-shaped hard plastic is embedded in the toothbrush. This design makes the brush easily bendable in the thinner horizontal direction, while being more rigid in the thicker vertical direction. It effectively balances flexibility during brushing with safety and cleaning efficacy.*

Impact Reduction Effect



POINT 5 Handle Design for Ease of Grip and Brushing

There are two main ways to hold a toothbrush: grasping it in the palm of one's hand (palm grip) and holding it like a pencil (pen grip). Our toothbrushes are meticulously designed based on ergonomics that consider how someone will hold and use the toothbrush. Our toothbrushes for final touchup brushing are specifically designed for pen grips, to prevent excessive force and facilitate detailed, thorough brushing. They feature a non-slip rubber grip and a conical, slim handle, which is easy to maneuver at various angles, even in the small mouths of children.



Toothbrushes for Finishing Touch Brushing



Our toothbrushes for infants and toddlers are designed with age- and development-appropriate grips.