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研究題目：ENAMEL MICROCRACKS INDUCED BY SIMULATED CCLUSAL WEAR IN MATURE, IMMATURE AND DECIDUOUS TEETH.

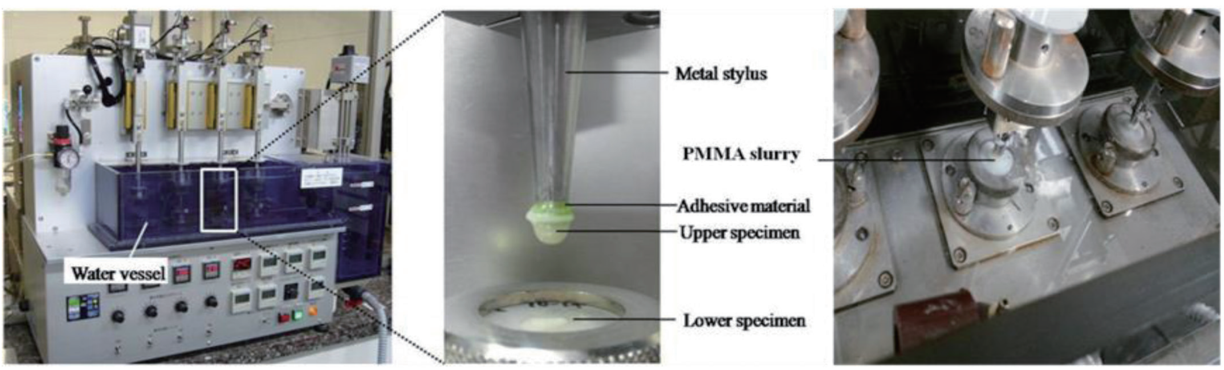
ACKGROUND AND AIM

Enamel wear, which is inevitable due to the process of mastication, is a process in which the microcracking of enamel occurs due to the surface contacting very small hard particles. When these particles slide on enamel, a combined process of micro-cutting and microcracking in the surface and subsurface of the enamel takes place.

The aim of this study was to detect microscopic differences in the microcrack behavior by subjecting enamel specimens derived from different age groups（immature open-apex premolars, mature closed-apex premolars and deciduous molars）to cycles of simulated impact and sliding wear testing（ISWT）under controlled conditions.

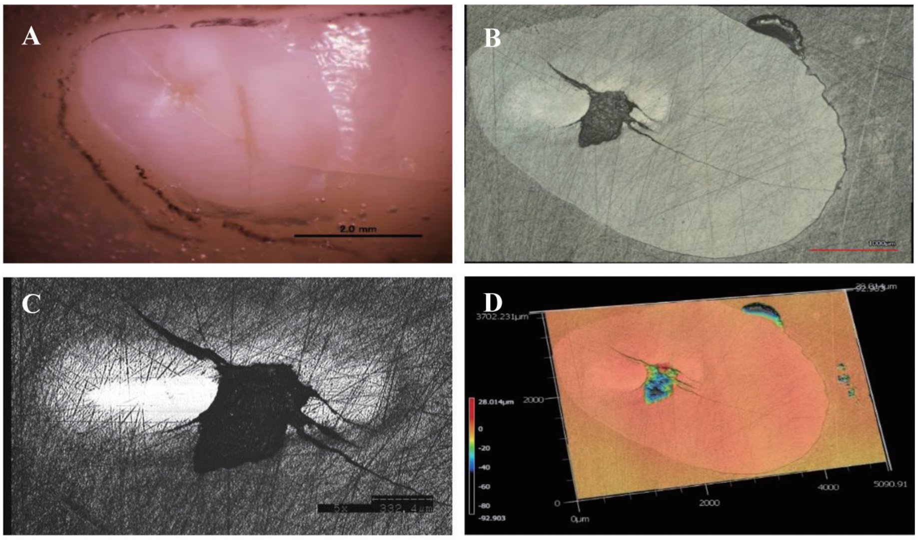
MATERIALS AND METHODS

Enamel specimens derived from forty-two immature premolars（9-15 yrs.）, forty mature premolars（25-30 yrs.）and twenty deciduous molars（8-11 yrs.）were prepared and subjected to $2x10^4$ cycles of ISWT under controlled conditions of temperature, size of specimens, force of impaction, and frequency. The wear created was examined by different microscopes to detect microcracks on both the enamel surface and subsurface



Impact sliding wear testing（ISWT）. Positions of the upper and lower enamel specimens below the water level in an impact sliding wear machine chamber. The whitish slurry of PMMA powder was placed in between specimens. The cyclic impact and sliding movements of the upper specimen against the lower specimen in relation to the zero/starting contact position were 1mm each. The test was conducted under controlled conditions ; impact Load : 30N, height and sliding distance : 1mm, and 37℃ of the water tank. After ISWT, all specimens were washed in distilled water for 20 seconds to remove any remnant slurry and dried with a gentle air spray. No polishing was performed as it might cause further damage to the existing wear features or produce new microcracks.

A scanning laser confocal microscope was first used to take images of the enamel windows. Different lenses were used to capture images of the microcracks pathway throughout the enamel windows. Specimens were then examined utilizing a 3D colored laser microscope and profilometer. The microcracks lengths and depths as well as the morphology and dimensions of the wear zone were measured. Three-dimensional images (3D images) of the specimens' surfaces were also constructed. To reveal the subsurface microcracks, specimens were examined using a fiber-optic stereo-microscope. Multiple images were taken with different illumination/transillumination directions for each specimen to ensure maximum contrast. Finally, the specimens were prepared and examined under a scanning electron microscope SEM in order to examine the relationship between the microcracks and the enamel microstructure.



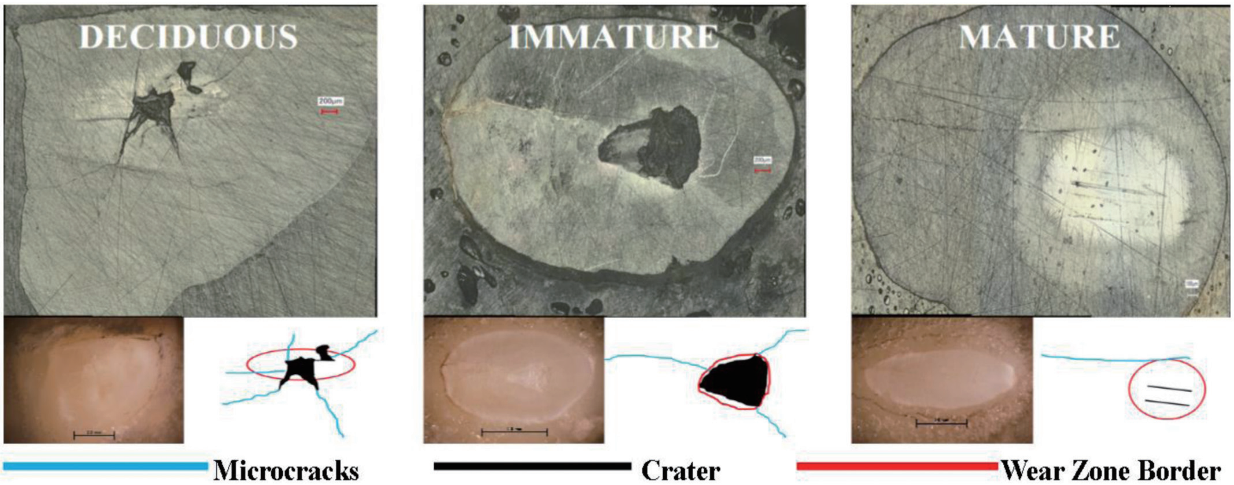
A: Stereomicroscope view.
B: Scanning laser microscope and profilometer.
C: Scanning confocal laser microscope.
D: Three-dimensional images were constructed with a depth scale

RESULTS

Differences in the microcracks characteristics were detected in many aspects between the study groups; Mature Premolars, Immature Premolars, and Deciduous Molars

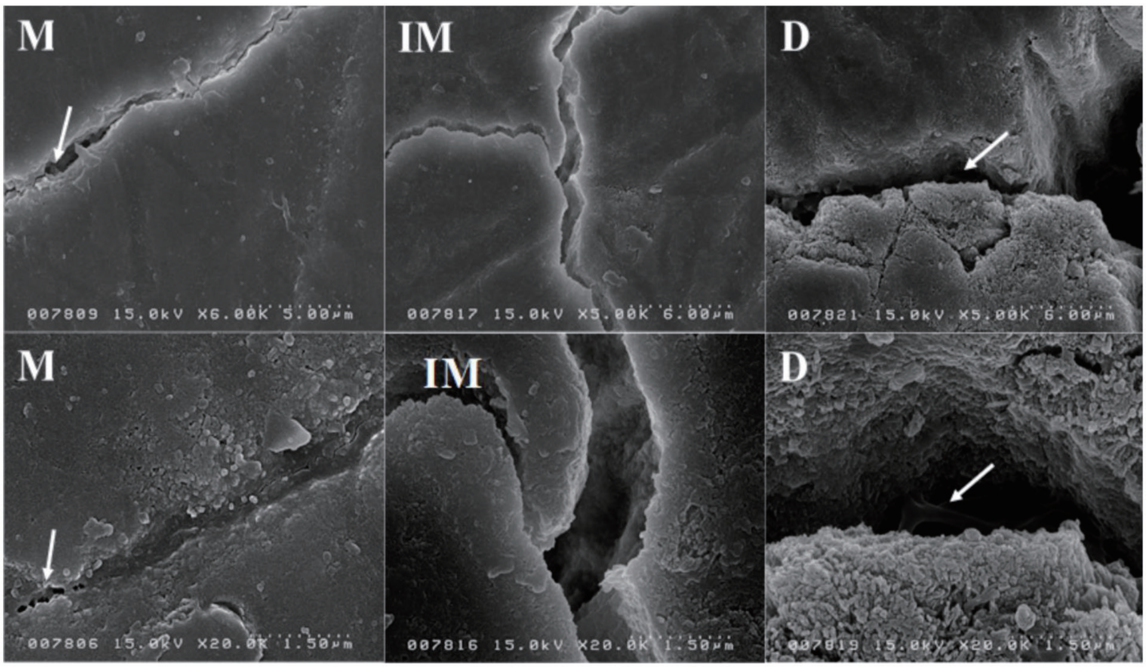
1. **Orientation of the microcracks and the wear zone.**

Deciduous and immature enamel had multiple microcracks radiating away from the wear zone while the mature group had minimal microcracks with a parallel direction.

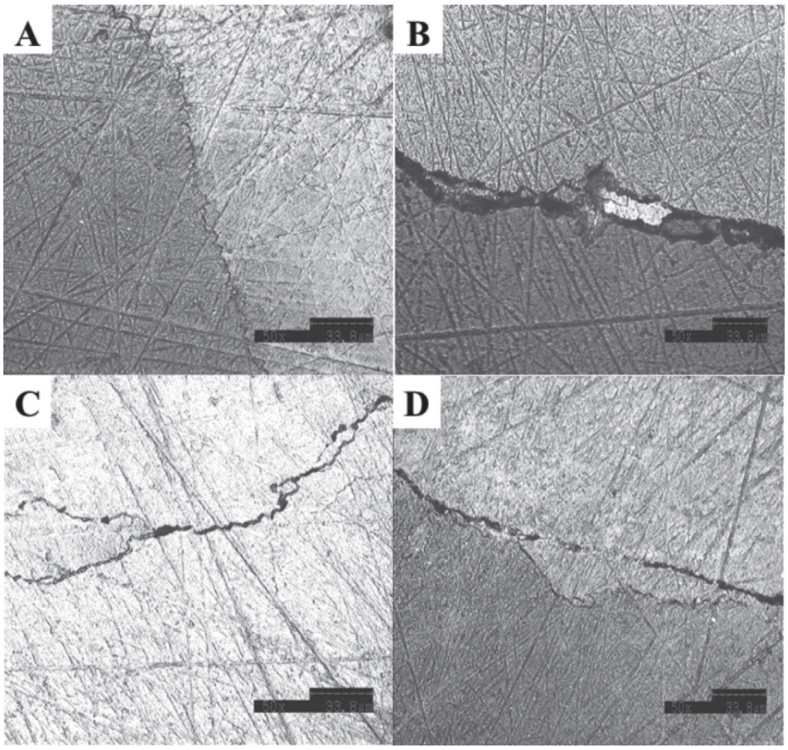


2. **Microstructural differences in microcracks pathways**

Mature group showed a compressed but preserved enamel microstructures. Microcracks were shallow incomplete separation. Deciduous group showed damage and separation of the enamel rods crystals with proteinous ligaments present. Immature group had a moderate damage in comparison.



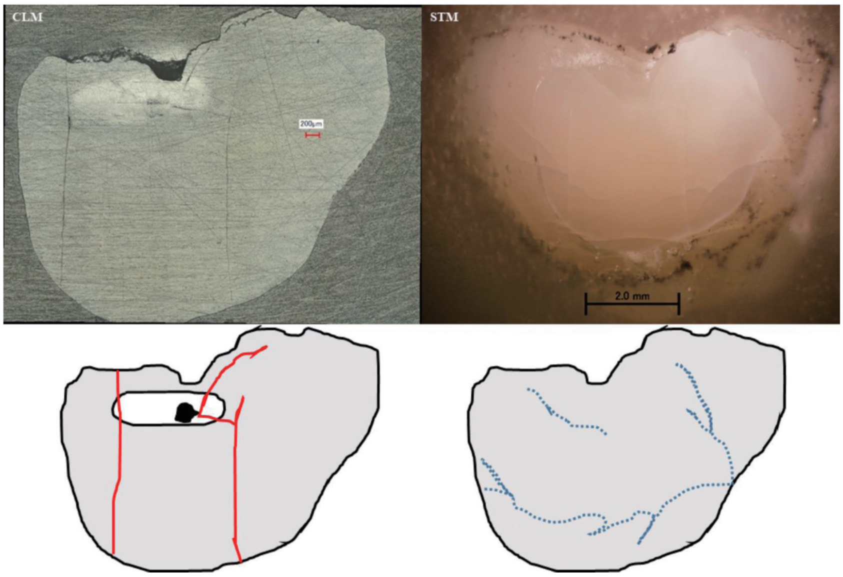
3. Various microcrack resistance mechanisms were detected on the enamel surface by the confocal laser microscope



A: Scalloping of the microcracks in the interrod area.
B: Bridging with incomplete separation of the enamel microstructures.
C: Curvature of the microcracks pathway.
D: Bifurcation of the microcracks in to two smaller cracks.

4. Microcracks measurements of length, number, and depth in surfaces and subsurfaces among the study groups5.

Parameter		**Groups**			***p*-value**
		Mature	**Immature**	**Deciduous**	
Number of surface microcracks	Median	4	7	9	
	Range	5	10	7	
	Maximum	7	13	13	
	Minimum	2	3	6	
	Rank†	a	b	b	≤ 0.001*
Total length of surface microcracks (mm)	Median	5.64	10.80	16.06	
	Range	10.44	15.89	17.25	
	Maximum	11.37	18.17	25.13	
	Minimum	0.93	2.28	7.88	
	Rank	a	b	b	≤ 0.001*
Number of subsurface microcracks	Median	2	3	6	
	Range	7	6	5	
	Maximum	7	6	9	
	Minimum	0	0	4	
	Rank	a	a	b	≤ 0.001*
Total length of sub-surface microcracks (mm)	Median	2.69	3.77	12.15	
	Range	6.20	9.90	24.98	
	Maximum	6.20	9.90	29.94	
	Minimum	0.00	0.00	4.96	
	Rank	a	a	b	≤ 0.001*
Depth of microcracks near wear zones (μm)††	Median	4.37	4.38	14.99	
	Range	17.04	25.68	24.43	
	Maximum	17.98	26.49	28.42	
	Minimum	0.94	0.81	3.99	
	Rank	a	a	b	0.005*



Deciduous group had the most extensive subsurface microcracks among the study groups.

CLM: Colored laser microscope. STM: Stereomicroscope with multi-fiberoptic illumination/transillumination.

The schematic presentation of the surface microcracks are in red, tracings of the subsurface microcrack are in blue.

5. Subsurface microcracks detected had its orientation, number and measurements different than surface microcracks

Conclusions

Enamel surface and subsurface microcracks characteristics are dependent on the post-eruptive age. Although deciduous enamel is least resistant to wear and microcracks in comparison to mature and immature permanent enamel, there are still significant differences in the wear resistance of the permanent enamel at different eruptive ages.

Clinical Significance

The presence of significant differences in the microcracks resistance of enamel at different ages suggests "A need to reconsider the physical properties of restorative materials applied in the futuristic treatment planning of dental wear" might exist.

Presentations

This research results were presented as a poster in the Japanese Association for Dental Research conference, JADR 65th Annual Meeting, Tokyo 2017.