

The effect of *in vitro* aging simulating wear on CAD/CAM restorative materials

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Introduction

- One of the *goals of in vitro studies* is to replicate the clinical environment. A chewing simulator simulates wear *in vitro* and is associated with several challenges, such as the number of cycles, load, aging medium, and contact time.
- In addition to abrasive wear, thermal and acidic challenges may cause further tooth surface loss during eating and drinking episodes.
- Resin nanoceramics, lithium disilicate and zirconia are often the materials of choice as CAD/CAM indirect restorations.
- The effect of the association between mechanical, thermal, and acidic challenges on the performance of dental restorative materials is unclear.

Aim

To evaluate the properties of CAD/CAM restorative materials after aging in a clinically relevant model that simulates five years of wear.

Methodology

	Control (CO)	Simulated mechanical and thermal challenges (MT)	Simulated mechanical, thermal, and acidic challenges (MTA)
RN			
LD			
ZR			

RN: Resin nanoceramic Lava Ultimate. LD: Lithium disilicate, IPS e.max CAD. ZR: High translucency zirconia Vita YZ. Disc shape: 12mm ø, 1.2 mm

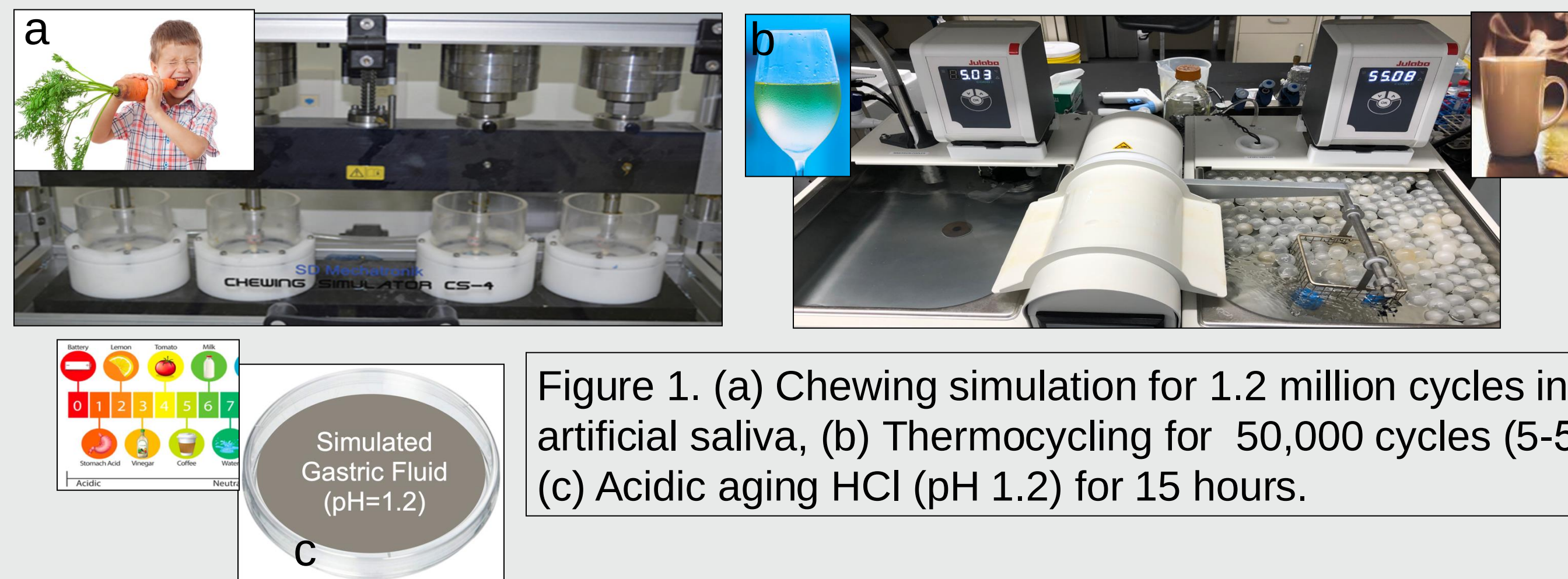


Figure 1. (a) Chewing simulation for 1.2 million cycles in artificial saliva, (b) Thermocycling for 50,000 cycles (5-55°C) (c) Acidic aging HCl (pH 1.2) for 15 hours.

Surface properties

Optical properties

Mechanical properties



Result

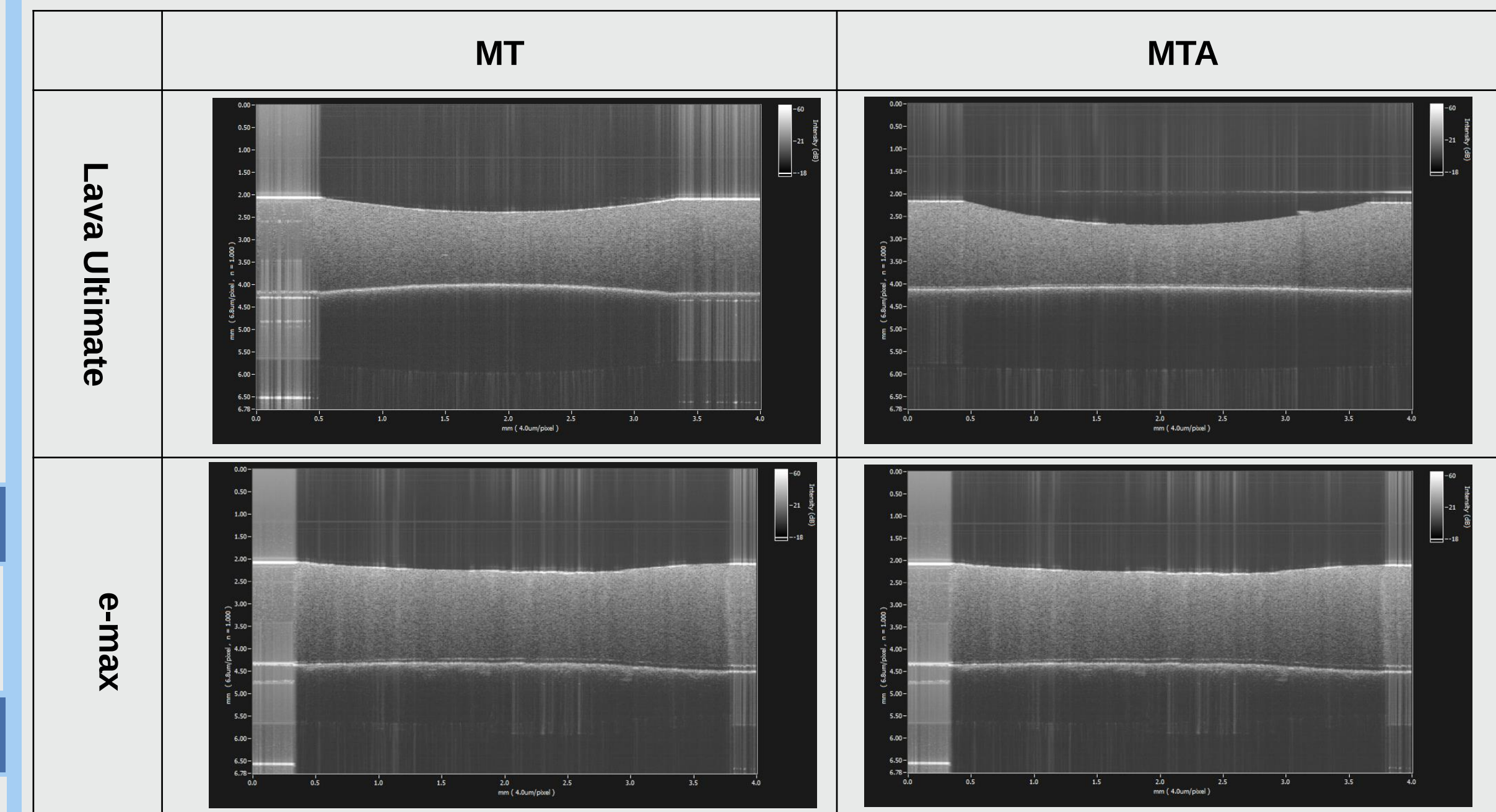


Figure 2: Vertical loss of resin nanoceramics and lithium disilicate after MT and MTA aging

2- Surface roughness

- MT and MTA increased the roughness of RN ($p = 0.00$) and LD ($p = 0.00$) compared to CO.
- There was no significant difference between MT and MTA for RN and LD.
- Aging had no significant effect on ZR roughness ($p = 0.83$).

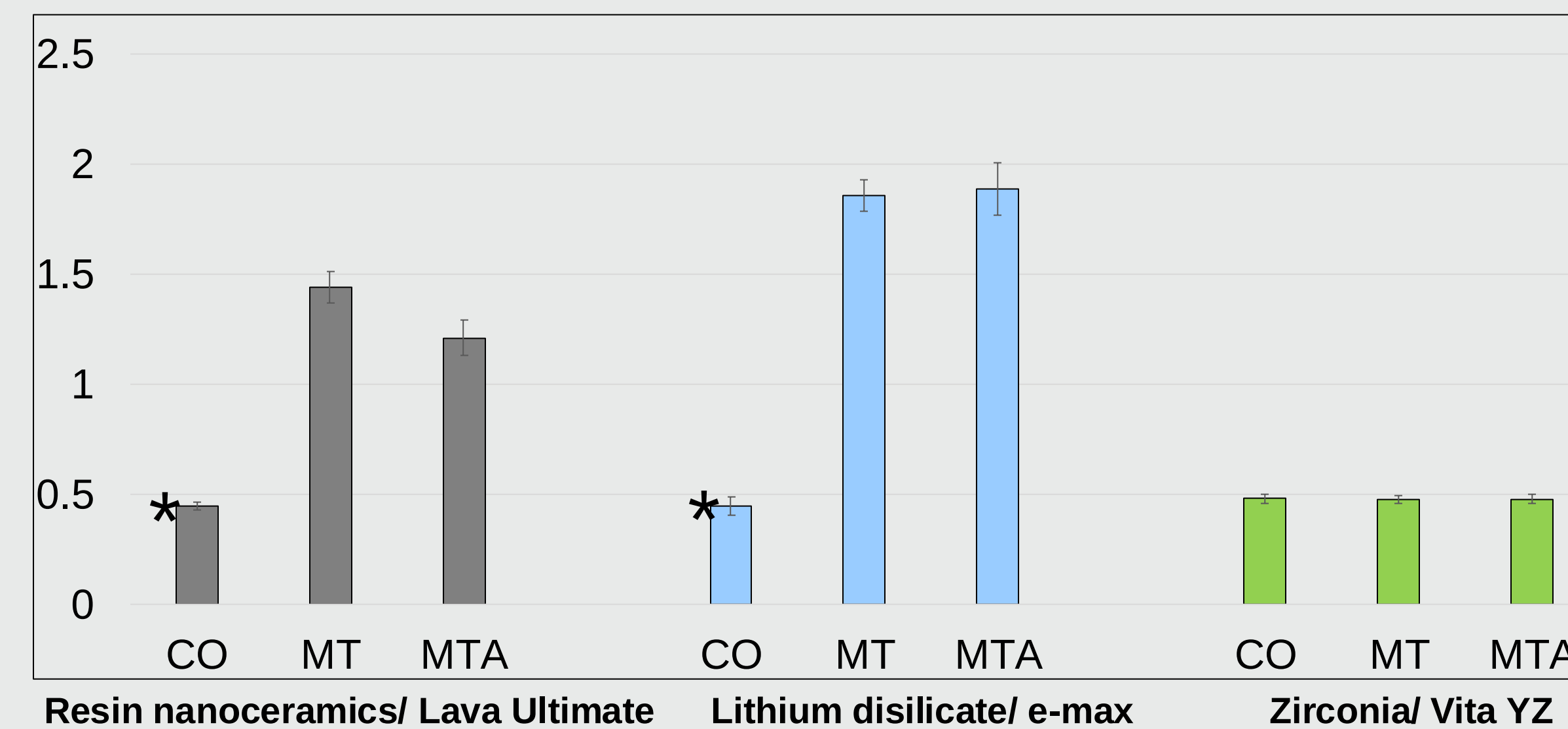


Figure 3: Surface roughness (in μm) of restorative materials. Asterisk represents a significant material effect on roughness (5 % significance)

3- Optical properties

- Aging did not affect the **translucency parameter** ($p > 0.46$) and **contrast ratio** ($p > 0.66$)
- There was no significant difference in **colour changes** after aging ($p > 0.1$).
- The colour changes after aging were below the acceptability threshold (3.7).

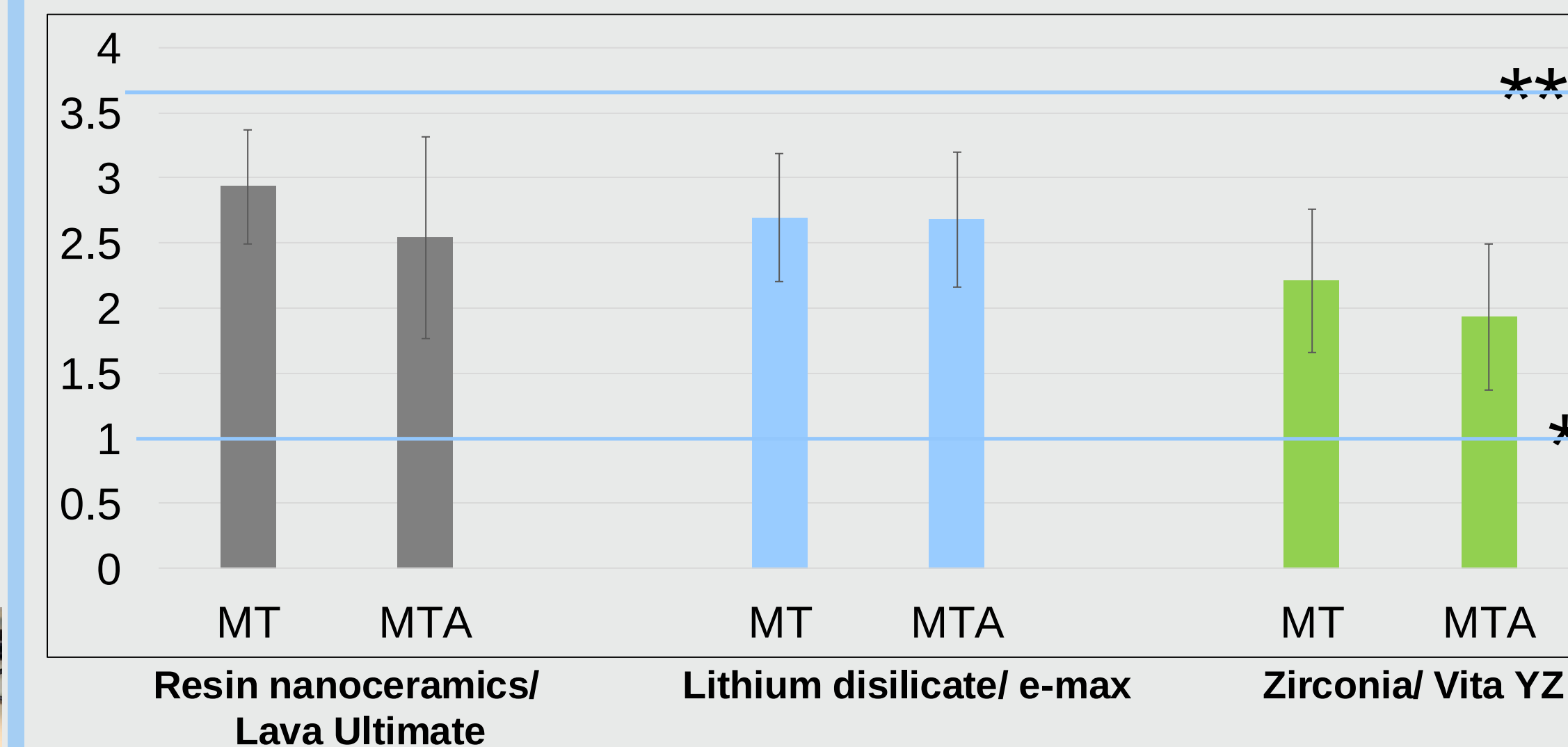


Figure 4: Color changes of CAD/CAM materials submitted to aging, considering the control group as baseline (*perceptibility threshold; **acceptability threshold).

1- Vertical loss

- MT resulted in $279 (\pm 34) \mu\text{m}$ of vertical loss for RN and $188 (\pm 23.1) \mu\text{m}$ for LD.
- MTA resulted in $294 (\pm 39) \mu\text{m}$ of vertical loss for RN and $190 (\pm 25) \mu\text{m}$ for LD.
- MT and MTA aging resulted in no vertical loss on the surface of ZR.

Table 1: Hardness and modulus of resin nanoceramic, lithium disilicate, and zirconia submitted to aging.

	Aging groups	Resin nanoceramics/ Lava Ultimate	Lithium disilicate/ e-max	Zirconia/ Vita YZ
Hardness (GPa)	CO	1.12 (± 0.1)	7.05 (± 0.45)	17.22 (± 1.43)
	MT	1.15 (± 0.88)	6.68 (± 0.86)	16.07 (± 1.26)
	MTA	1.47 (± 0.8)	6.93 (± 0.97)	16.11 (± 2.07)
Elastic modulus (GPa)	CO	15.59 (± 0.9)	83.29 (± 4.7)	212.43 (± 10.27)
	MT	15.94 (± 0.7)	79.43 (± 7.79)	201.76 (± 8.23)
	MTA	15.76 (± 0.75)	80.74 (± 6.07)	209.46 (± 13.98)

4- Hardness and modulus

Aging did not affect the hardness ($p > 0.22$) or elastic modulus ($p > 0.1$) of any of the materials evaluated in comparison to the CO group.

Table 2: Flexural strength (in MPa) of resin nanoceramic, lithium disilicate, and zirconia after MT and MTA aging compared to the control group

Aging groups	Resin nanoceramics/ Lava Ultimate	Lithium disilicate/ e-max	Zirconia/ Vita YZ
CO	125.54 MPa (12.14) ^a	344.5 MPa (20.21) ^a	909.67 MPa (34.4) ^a
MT	94.43 MPa (11.83) ^b	178.76 MPa (11.9) ^b	411.11 MPa (24.23) ^b
MTA	92.09 MPa (8.35) ^b	162.27 MPa (14.37) ^b	435.03 MPa (18.85) ^b

Different letters in each column represent the significance level of each tested material (5% significant level).

Conclusion

- Experimental aging methods negatively affected resin nanoceramic and lithium disilicate surface properties, resulting in vertical surface loss and increased roughness.
- Aging did not affect the surface properties of high translucency zirconia.
- Mechanical, thermal and acidic aging did not affect the optical properties of CAD/CAM-tested materials.
- Regarding mechanical properties, both aging methods decreased the flexural strength of CAD/CAM materials; however, aging did not affect the hardness or modulus of resin nanoceramic, lithium disilicate, and zirconia.
- There was no difference between any treatment groups (MT, MTA) on the surface, optical, and mechanical properties of resin nanoceramics, lithium disilicate, and high-translucency zirconia.

Acknowledgement

