



- Review the medical and dental histories.
- Diagnose the severity and site-specific distribution.
- Have the patient record their dietary intake over four days and estimate their erosive potential.
- Question the patient for specific factors that they may not be aware of:
 - Diet: Herbal teas, acidic candies, alcohol, sports drinks, effervescent Vitamin C tablets, etc.
 - Gastric symptoms: Vomiting, acidic taste in the mouth, gastric pain (especially when awakening, stomach ache), any sign of anorexia or bulimia nervosa.
 - Drugs: Alcohol, tranquilizer, antiemetics, antihistamines, lemonade tablets. (Change of acidic or saliva-reducing drugs is possible in consultation with the patient's physician).
- Determine the flow rate and buffering capacity of their saliva.
- Reveal their oral hygiene habits, the abrasivity of their toothpaste and technique as well as the type of mouthrinse they use, if any.
- Question the patient for occupational exposure to acidic environments, e.g., at battery or galvanizing factories, or through wine tasting or professional swimming.¹
- Question the patient for X-ray therapy of the head and neck area.
- A study found that the average pH of the mouth during the day is 7.3, with a range of 7.1-8.1, while at night, the average pH of the mouth is 7.0 with a range of 5.0-7.8. However, those who are known mouth breathers during sleep have been found to have an average mouth pH of 6.6 with a range of 3.6-7.2. Therefore, question the patient on whether they are a known mouth breather as this study suggests that mouth breathing during sleep is related to a decrease in intraoral pH compared with normal breathing during sleep, and this has been proposed as a causal factor for dental erosion and caries.²
- Assess further progression with silicone impressions, study models, photographs, and/or digital scans as well as the Basic Erosive Wear Examination.³

References:

1. Kanzow P, Wegehaupt FJ, Attin T, Wiegand A. Etiology and pathogenesis of dental erosion. *Quintessence Int.* 2016 Apr;47(4):275-8.
2. Choi JE, Waddell JN, Lyons KM, Kieser JA. Intraoral pH and temperature during sleep with and without mouth breathing. *J Oral Rehabil.* 2016 May;43(5):356-63.
3. Bartlett D, Ganss C, Lussi A. Basic Erosive Wear Examination (BEWE): a new scoring system for scientific and clinical needs *Clin Oral Investig.* 2008 Mar;12 Suppl 1:S65-8.



TABLE 1

pH of Waters and Sports Drinks

Water and Sports Drinks	pH (stand. dev.)
Activ Water Focus Dragonfruit	2.82 (0.04)
Activ Water Vigor Triple Berry	2.67 (0.01)
Gatorade Frost Riptide Rush	2.99 (0.01)
Gatorade Lemon-Lime	2.97 (0.01)
Gatorade Orange	2.99 (0.00)
Powerade Fruit Punch	2.77 (0.01)
Powerade Grape	2.77 (0.01)
Powerade Lemon Lime	2.75 (0.01)
Powerade Mountain Berry Blast	2.82 (0.01)
Powerade Orange	2.75 (0.02)
Powerade Sour Melon	2.73 (0.00)
Powerade Strawberry Lemonade	2.78 (0.01)
Powerade White Cherry	2.81 (0.01)
Powerade Zero Grape	2.97 (0.01)
Powerade Zero Lemon Lime	2.92 (0.00)
Powerade Zero Mixed Berry	2.93 (0.01)
Powerade Zero Orange	2.93 (0.01)
Activ Water Power Strawberry Kiwi	3.38 (0.03)
Clear American Kiwi Strawberry	3.70 (0.01)
Clear American Pomegranate Blueberry Acai	3.24 (0.01)
Clear American Tropical Fruit	3.07 (0.01)
Clear American White Grape	3.43 (0.01)
Dasani Grape	3.05 (0.01)
Dasani Lemon or Strawberry	3.03 (0.01)
Gatorade Blueberry Pomegranate Low Calorie	3.21 (0.01)
Gatorade Fierce Grape or Melon	3.05 (0.00)
Gatorade Fruit Punch	3.01 (0.01)
Gatorade Rain Berry	3.17 (0.01)
Gatorade Rain Lime	3.19 (0.01)
Gatorade Rain Strawberry Kiwi	3.17 (0.01)
Propel Berry	3.01 (0.00)
Propel Grape	3.10 (0.01)
Propel Kiwi Strawberry	3.17 (0.00)
Propel Lemon	3.03 (0.00)
S. Pellegrino Sparkling Natural Mineral Water	4.96 (0.09)
Skinny Water Acai Grape Blueberry	3.81 (0.02)
Skinny Water Goji Fruit Punch	3.67 (0.01)
Skinny Water Raspberry Pomegranate	3.68 (0.01)
Sobe Life Water Acai Fruit Punch	3.22 (0.01)
Sobe Life Water Blackberry Grape	3.15 (0.01)
Sobe Life Water Cherimoya Punch	3.28 (0.00)
Sobe Life Water Fuji Apple Pear	3.53 (0.01)
Sobe Life Water Mango Melon	3.29 (0.01)
Sobe Life Water Strawberry Dragonfruit	3.32 (0.01)
Vidration Vitamin Enhanced Water Defense Pomegranate-Acai-Blueberry	2.92 (0.01)
Vidration Vitamin Enhanced Water Energy Tropical Citrus	2.91 (0.01)
Vidration Vitamin Enhanced Water Multi-V Lemon Lime	3.59 (0.01)
Vidration Vitamin Enhanced Water Recover Fruit Punch	3.61 (0.01)
Vitamin Water Connect Black Cherry-Lime	2.96 (0.01)
Vitamin Water Dwnld Berry-Cherry	3.04 (0.01)
Vitamin Water Energy Tropical Citrus	3.15 (0.01)
Vitamin Water Essential Orange-Orange	3.23 (0.00)
Vitamin Water Focus Kiwi-Strawberry	3.04 (0.01)
Vitamin Water Multi-V Lemonade	3.19 (0.01)
Vitamin Water Power C Dragonfruit	3.05 (0.00)
Vitamin Water Revive Fruit Punch	3.65 (0.01)
Vitamin Water Spark Grape-Blueberry	3.19 (0.01)
Vitamin Water XXX Acai-Blueberry-Pomegranate	2.98 (0.01)
Vitamin Water Zero Go-Go Mixed Berry	3.08 (0.01)
Vitamin Water Zero Mega C Grape-Raspberry	3.05 (0.00)
Vitamin Water Zero Recoup Peach-Mandarin	3.01 (0.01)
Vitamin Water Zero Rise Orange	3.46 (0.00)
Vitamin Water Zero Squeezed Lemonade	3.19 (0.00)
Vitamin Water Zero XXX Acai-Blueberry-Pomegranate	3.05 (0.01)
Minimally Erosive	
Aquafina regular	6.11 (0.23)
Birmingham, Alabama, municipal water	7.20 (0.05)
Dasani regular	5.03 (0.04)
Perrier carbonated mineral water	5.25 (0.10)

TABLE 2

pH of Energy Drinks

Energy Drinks	pH (stand. dev.)
24:7 Energy Cherry Berry	2.61 (0.01)
180 Blue Orange Citrus Blast	2.82 (0.00)
180 Blue With Acai	2.82 (0.01)
5-Hour Energy Berry	2.81 (0.03)
5-Hour Energy Extra Strength	2.82 (0.00)
5-Hour Energy Lemon-Lime	2.81 (0.00)
Amp Energy Elevate	2.79 (0.01)
Amp Energy Overdrive	2.78 (0.01)
Amp Energy regular	2.81 (0.01)
Amp Energy Sugar Free	2.86 (0.01)
Jolt Blue Bolt	2.96 (0.00)
Jolt Passion Fruit	2.82 (0.01)
Jolt Power Cola	2.47 (0.01)
Meltdown Energy Peach Mango	2.77 (0.00)
No Fear regular	2.97 (0.02)
Orange County Choppers	2.78 (0.02)
Purple Stuff Lean	2.87 (0.01)
Redline Peach Mango	2.74 (0.02)
Redline Princess Exotic Fruit	2.85 (0.01)
Redline Triple Berry	2.77 (0.01)
Rockstar Energy Drink	2.74 (0.01)
Rockstar Punched (Energy + Punch)	2.83 (0.01)
Rockstar Recovery	2.84 (0.01)
Crunk Citrus	3.20 (0.01)
Crunk Energy Drink	3.31 (0.01)
Crunk Grape Acai Energy Drink	3.30 (0.01)
Crunk Low Carb Sugar Free	3.34 (0.00)
Drank	3.09 (0.01)
Fuel Energy Shots Lemon Lime	3.97 (0.01)
Fuel Energy Shots Orange	3.44 (0.01)
Full Throttle Blue Agave	3.10 (0.01)
Full Throttle Citrus	3.09 (0.01)
Full Throttle Red Berry	3.08 (0.01)
Hydrive Blue Raspberry	3.45 (0.01)
Hydrive Citrus Burst	3.03 (0.01)
Hydrive Lemon Lime	3.42 (0.01)
Hydrive Triple Berry	3.15 (0.01)
Jolt Ultra Sugar Free	3.14 (0.00)
Killer Buzz	3.23 (0.01)
Killer Buzz Sugar Free	3.36 (0.00)
Monster Assault	3.58 (0.01)
Monster Energy	3.48 (0.01)
Monster Hitman Energy Shot	3.44 (0.01)
Monster Khaos	3.47 (0.01)
Monster Low Carb	3.60 (0.01)
Monster M-80	3.29 (0.00)
Monster MIXXD	3.35 (0.00)
Nitrous Monster Anti-Gravity	3.64 (0.01)
Nitrous Monster Killer B	3.31 (0.00)
Nitrous Monster Super Dry	3.46 (0.00)
No Fear Sugar Free	3.06 (0.01)
NOS Fruit Punch	3.32 (0.00)
NOS Grape	3.27 (0.01)
NOS High Performance Energy Drink	3.31 (0.01)
NOS Power Shot	3.03 (0.02)
Redbull regular	3.43 (0.01)
Redbull Shot	3.25 (0.03)
Redbull Sugar Free	3.39 (0.00)
Redbull Sugar Free Shot	3.28 (0.02)
Redline Xtreme Grape	3.23 (0.01)
Redline Xtreme Triple Berry	3.24 (0.01)
Redline Xtreme Watermelon	3.41 (0.00)
Rhinos Energy Drink	3.51 (0.01)
Rhinos Sugar Free Energy Drink	3.32 (0.01)
Rockstar Energy Cola	3.14 (0.01)
Rockstar Juiced Energy + Guava	3.16 (0.01)
Rockstar Juiced Energy + Juice Mango Orange Passion	3.05 (0.01)
Rockstar Sugar Free	3.15 (0.03)



TABLE 3

pH of Fruit Drinks and Fruit Juices.

Fruit Drinks	pH (stand. dev.)
Barber's Lemonade	2.69 (0.00)
Barber's Orange Drink	2.96 (0.00)
Bug Juice Berry Raspberry	2.99 (0.01)
Bug Juice Grapey Grape	2.83 (0.00)
Country Time Lemonade	2.72 (0.01)
Crystal Light Fruit Punch	2.96 (0.02)
Crystal Light Raspberry Ice	2.77 (0.01)
Hi-C Tropical	2.81 (0.03)
Kool-Aid Mix Cherry	2.71 (0.00)
Kool-Aid Mix Grape	2.83 (0.01)
Kool-Aid Mix Lemon-Lime	2.73 (0.01)
Kool-Aid Mix Orange	2.77 (0.01)
Kool-Aid Mix Pink Lemonade	2.66 (0.01)
Kool-Aid Mix Tropical Punch	2.69 (0.00)
Minute Maid Fruit Punch	2.86 (0.00)
Minute Maid Lemonade	2.57 (0.01)
Minute Maid Orangeade	2.85 (0.00)
Minute Maid Pink Lemonade	2.59 (0.00)
Simply Lemonade	2.61 (0.01)
Snapple Kiwi Strawberry	2.77 (0.01)
Snapple Mango Madness	2.89 (0.01)
Sobe Black and Blueberry Brew	2.69 (0.00)
Sobe Citrus Energy	2.63 (0.00)
Sobe Power Fruit Punch	2.43 (0.02)
Sobe Strawberry Banana	2.62 (0.01)
Sun Fresh Lemonade	2.68 (0.01)
Sunny D Smooth	2.92 (0.01)
Sunny D Tangy Original	2.86 (0.01)
Tropicana Cranberry Cocktail	2.70 (0.01)
Tropicana Juice Beverage Cranberry	2.59 (0.00)
Tropicana Juice Beverage Grape	2.58 (0.00)
Tropicana Lemonade	2.70 (0.01)
Tropicana Twister Blue Raspberry Rush	2.62 (0.00)
Tropicana Twister Cherry Berry Blast	2.63 (0.00)
Tropicana Twister Orange Strawberry Banana Burst	2.89 (0.01)
Tropicana Twister Strawberry Kiwi Cyclone	2.59 (0.01)
Welch's Blueberry Kiwi Blast	2.57 (0.01)
Welch's Cranberry	2.59 (0.02)
Welch's Grape Juice Cocktail	2.92 (0.01)
Welch's Ruby Red Grapefruit Juice	2.97 (0.01)
Barber's Fruit Punch	2.96 (0.00)
Bug Juice Fruity Punch	3.09 (0.00)
Bug Juice Leapin Lemonade	3.06 (0.00)
Bug Juice Whistlin Watermelon	3.40 (0.01)
CapriSun Surfer Cooler	3.08 (0.00)
Crystal Light Green Tea Raspberry Mix	3.11 (0.02)
Fuze Banana Colada	3.45 (0.03)
Fuze Blueberry Raspberry	3.20 (0.01)
Fuze Green Tea Honey and Ginseng	3.28 (0.02)
Fuze Orange Mango	3.34 (0.02)
Fuze Peach Mango	3.53 (0.01)
Fuze Strawberry Banana	3.54 (0.01)
Fuze Strawberry Guava	3.55 (0.02)
Fuze Strawberry Melon	3.18 (0.01)
Fuze Tropical Punch	3.17 (0.01)
Jumex Guava	3.38 (0.02)
Jumex Mango	3.41 (0.01)
Jumex Peach	3.33 (0.02)
Jumex Strawberry Banana	3.68 (0.01)
Kool-Aid Burst (Tropical)	3.07 (0.01)
Little Hug Grape	3.09 (0.01)
Little Hug Orange	3.00 (0.01)
Mondo (Legendary Berry)	3.07 (0.01)
Mondo (Primo Punch)	3.10 (0.01)
Sesame Street Elmo's Punch	3.87 (0.01)
Sobe Fuji Apple Cranberry (low calorie)	3.16 (0.01)
Sobe Orange Carrot	3.34 (0.00)
Sobe Pina Colada	3.25 (0.01)
TumE Yummies Fruitabulous Punch	3.35 (0.00)
TumE Yummies Orangearific	3.34 (0.01)
TumE Yummies Soursational Raspberry	3.18 (0.00)
TumE Yummies Very Berry Blue	3.33 (0.00)
Vitamin Stix Dragonfruit Acai	3.11 (0.01)
Vitamin Stix Passionfruit Citrus	3.19 (0.01)
Vitamin Stix Strawberry Kiwi	3.06 (0.01)
Welch's Orange Pineapple	3.20 (0.01)
Welch's Strawberry Kiwi	3.03 (0.01)

Fruit Juices	pH (stand. dev.)
Lemon juice	2.25 (0.01)
Minute Maid Cranberry Apple Raspberry	2.79 (0.01)
Minute Maid Cranberry Grape	2.71 (0.01)
Ocean Spray Cranberry	2.56 (0.00)
Ocean Spray Cran-Grape	2.79 (0.01)
Ocean Spray Cran-Pomegranate	2.72 (0.01)
Ocean Spray Strawberry Kiwi Juice Cocktail	2.90 (0.01)
V8 Splash Berry Blend	2.94 (0.01)
V8 Splash Strawberry Kiwi	2.99 (0.01)
V8 Splash Tropical Blend	2.93 (0.00)
Amp Energy Juice Mixed Berry	3.62 (0.01)
Amp Energy Juice Orange	3.60 (0.01)
Barber's Orange Juice	3.81 (0.01)
Dole Pineapple Juice	3.40 (0.01)
Juicy Juice Apple	3.64 (0.01)
Juicy Juice Berry	3.78 (0.01)
Juicy Juice Sparkling Apple	3.47 (0.01)
Juicy Juice Sparkling Berry	3.50 (0.01)
Juicy Juice Sparkling Orange	3.49 (0.01)
Minute Maid Apple Juice	3.66 (0.01)
Minute Maid Natural Energy Mango Tropical	3.34 (0.02)
Minute Maid Natural Energy Pomegranate Berry	3.33 (0.01)
Minute Maid Natural Energy Strawberry Kiwi	3.40 (0.01)
Minute Maid Orange Juice	3.82 (0.01)
Minute Maid Pineapple Orange	3.71 (0.01)
Minute Maid Ruby Red Grapefruit Juice	3.07 (0.03)
Naked Blue Machine	3.81 (0.01)
Naked Orange Mango	3.75 (0.01)
Ocean Spray Orange Juice	3.83 (0.01)
Ocean Spray Pineapple Peach Mango Juice Blend	3.64 (0.01)
Ocean Spray Ruby Red	3.07 (0.01)
Simply Apple	3.67 (0.01)
Simply Orange Orange Juice	3.78 (0.00)
Tango Energy Juice	3.47 (0.00)
Tropicana 100% Juice Apple Juice	3.50 (0.02)
Tropicana 100% Juice Orange Juice	3.80 (0.01)
Tropicana Apple Orchard Style Juice	3.57 (0.00)
Tropicana Grape Juice	3.29 (0.01)
V8 Fusion Cranberry Blackberry	3.56 (0.01)
V8 Fusion Pomegranate Blueberry	3.66 (0.00)
V8 Fusion Strawberry Banana	3.66 (0.00)
Very Fine Grapefruit Juice	3.22 (0.03)
Welch's 100% Grape Juice	3.38 (0.00)
Welch's Apple Juice	3.57 (0.01)
Welch's Orange Juice	3.73 (0.00)
Minimally Erosive	
Campbell's Tomato Juice	4.01 (0.01)
Naked Protein Zone	4.69 (0.01)
Tropicana Orange Juice (With Calcium)	4.09 (0.01)
V8 Vegetable Juice	4.23 (0.01)
V8 Vegetable Juice Low Sodium	4.17 (0.01)
V8 Vegetable Juice Spicy Hot	4.19 (0.00)

TABLE 4

pH of Teas and Coffee.

Teas and Coffee	pH (stand. dev.)
Admiral Iced Tea Raspberry	2.94 (0.00)
Arizona Iced Tea	2.85 (0.03)
Lipton Green Tea With Citrus	2.93 (0.00)
Lipton Green Tea With Citrus Diet	2.92 (0.00)
Nestea Iced Tea With Natural Lemon Flavor	2.94 (0.01)
Nestea Red Tea Pomegranate and Passion Fruit	2.87 (0.01)
Snapple Peach Tea	2.94 (0.01)
Snapple Raspberry Tea	2.92 (0.00)
Admiral Iced Tea Green Tea	3.72 (0.01)
Admiral Iced Tea Mango	3.41 (0.00)
Admiral Iced Tea Sweet Tea	3.76 (0.01)
Arizona Diet Green Tea + Ginseng	3.29 (0.01)
Snapple Diet Raspberry Tea	3.39 (0.02)
Snapple Diet Peach Tea	3.32 (0.01)
Minimally Erosive	
Milo's Famous Sweet Tea	4.66 (0.02)
Milo's No Calorie Famous Sweet Tea	5.18 (0.03)
Red Diamond Tea Fresh Brewed Sweet Tea	5.04 (0.02)
Starbucks Medium Roast	5.11 (0.05)



TABLE 5

pH of Sodas

Soda	pH (stand. dev.)
7UP Cherry	2.98 (0.01)
Boylan's Black Cherry	2.76 (0.02)
Boylan's Grape	2.91 (0.01)
Boylan's Sugar Cane Cola	2.54 (0.01)
Canada Dry Ginger Ale	2.82 (0.01)
Coca-Cola Caffeine Free	2.34 (0.03)
Coca-Cola Cherry	2.38 (0.03)
Coca-Cola Cherry Zero	2.93 (0.01)
Coca-Cola Classic	2.37 (0.03)
Coca-Cola Lime Diet	2.96 (0.03)
Coca-Cola Zero	2.96 (0.03)
Crush Grape	2.76 (0.01)
Crush Orange	2.87 (0.01)
Dr. Pepper	2.88 (0.04)
Fanta Grape (2 liter)	2.67 (0.02)
Fanta Orange	2.82 (0.02)
Fanta Pineapple (2 liter)	2.79 (0.02)
Fanta Strawberry	2.84 (0.01)
Grapico	2.77 (0.03)
Hansen's Cane Soda Cherry Vanilla Crème	2.91 (0.01)
Hansen's Cane Soda Kiwi Strawberry	2.59 (0.01)
Hansen's Cane Soda Mandarin Lime	2.57 (0.01)
Hansen's Cane Soda Pomegranate	2.55 (0.00)
Hawaiian Punch (Fruit Juicy Red)	2.87 (0.01)
Jolly Rancher Grape	2.60 (0.01)
Jolly Rancher Orange	2.88 (0.01)
Jones Blue Bubblegum	2.99 (0.01)
Jones Green Apple Soda	2.65 (0.01)
Jones Mandarin Orange	2.93 (0.00)
Jones M.F. Grape	2.89 (0.02)
Jones Orange & Cream Soda	2.79 (0.01)
Jones Strawberry Lime	2.81 (0.02)
Mr. Pibb Xtra	2.80 (0.01)
Natural Brew Draft Root Beer	2.90 (0.00)
Pepsi	2.39 (0.03)
Pepsi Max	2.74 (0.01)
Pepsi Max Ceasefire	2.70 (0.01)
Pepsi Wild Cherry	2.41 (0.03)
RC Cola	2.32 (0.02)
Schweppes Tonic Water	2.54 (0.03)
Sunkist Orange	2.98 (0.01)
Sunkist Peach	2.89 (0.01)
Sunkist Strawberry	2.99 (0.01)
Tab	2.72 (0.01)
Vault	2.77 (0.02)
Vault Red Blitz	2.80 (0.01)
Vault x	2.89 (0.03)
7UP	3.24 (0.02)

Soda	pH (stand. dev.)
7UP Diet	3.48 (0.00)
A&W Cream Soda	3.86 (0.01)
Ale 8-One	3.13 (0.01)
Boylan's Orange Cream	3.59 (0.01)
Boylan's Orange Soda	3.22 (0.00)
Boylan's Original Birch Beer	3.80 (0.00)
Buffalo Rock Ginger Ale	3.23 (0.01)
Coca-Cola Caffeine Free Diet	3.04 (0.01)
Coca-Cola Diet	3.10 (0.05)
Dr Pepper Cherry	3.06 (0.02)
Dr Pepper Diet	3.20 (0.00)
Dr Pepper Diet Cherry	3.32 (0.01)
Fresca (1 liter)	3.08 (0.01)
Grapico Diet	3.04 (0.01)
Hansen's Cane Soda Black Cherry Diet	3.47 (0.02)
Hansen's Cane Soda Creamy Root Beer Diet	3.73 (0.01)
Izze Sparkling Blackberry	3.28 (0.01)
Izze Sparkling Clementine	3.27 (0.01)
Izze Sparkling Pomegranate	3.01 (0.01)
Jones Cream Soda	3.04 (0.01)
Jones Red Apple	3.40 (0.02)
Jones Root Beer	3.42 (0.02)
Mellow Yellow	3.03 (0.00)
Mountain Dew (regular)	3.22 (0.07)
Mountain Dew Code Red	3.27 (0.01)
Mountain Dew Diet	3.18 (0.01)
Mountain Dew Voltage	3.05 (0.01)
Mug Root Beer	3.88 (0.02)
Pepsi Diet	3.02 (0.01)
Sierra Mist	3.09 (0.02)
Sierra Mist Diet	3.31 (0.01)
Sprite	3.24 (0.05)
Sprite Zero	3.14 (0.01)
Sunkist Diet	3.49 (0.01)
Sunkist Solar Fusion Tropical Mandarin	3.02 (0.01)
Welch's Grape Soda	3.11 (0.02)
Minimally Erosive	
A&W Root Beer	4.27 (0.02)
A&W Root Beer Diet	4.57 (0.00)
Barq's Root Beer	4.11 (0.02)
Boylan's Creme Soda	4.17 (0.02)
Boylan's Diet Black Cherry	4.00 (0.01)
Boylan's Diet Root Beer	4.05 (0.02)
Boylan's Root Beer	4.01 (0.01)
Canada Dry Club Soda	5.24 (0.03)
IBC Root Beer	4.10 (0.02)
Maine Root Root Beer	4.36 (0.02)

Reference:

Reddy A, Norris DF, Momeni SS, Waldo B, Ruby JD. The pH of beverages in the United States. J Am Dent Assoc. 2016 Apr;147(4):255-63.



TABLE 6

Acidity of Common Foods and Beverages

Beverages	pH Range
Cider	2.9-3.3
Beers	4.0-5.0
Wines	2.3-3.8
Fruits	pH Range
Apples	2.9-3.5
Apricots	3.5-4.0
Grapes	3.3-4.5
Peaches	3.1-4.2
Pears	3.4-4.7
Plums	2.8-4.6
Grapefruit	3.0-3.5
Lemons, Limes/Juice	1.8-2.4
Oranges/Juice	2.8-4.0
Pineapples/Juice	3.2-4.1
Blueberries	3.2-3.6
Cherries	3.2-4.7
Strawberries	3.0-4.2
Raspberries	2.9-3.7
Tomatoes	3.7-4.7
Condiments	pH Range
Mayonnaise	3.8-4.0
Vinegar	2.4-3.4
A-1® Sauce	3.4
Mustard	3.6
Italian salad dressing	3.3
Cranberry sauce	2.3
Sauerkraut	3.1-3.7
Relish	3.0
Ketchup	3.7
Sour cream	4.4
Other	pH Range
Yogurt	3.8-4.2
Pickles	2.5-3.0
Rhubarb	2.9-3.3
Vegetables/fermented	3.9-5.1
Fruit jam/jellies	3.0-4.0

Reference: Clark DC, Woo G, Silver JG, Sweet D, Grisdale JC. The influence of frequent ingestion of acids in the diet on treatment for dentin sensitivity. *J Can Dent Assoc.* 1990 Dec;56(12):1101-3.

TABLE 8

Mean pH of Oral Moisturizers

Oral Moisturizer	Mean pH (SD)
Oasis	6.33 (0.28)
Biotène MS	6.11 (0.03)
CTx2 Spray	9.09 (0.05)
Mouth Kote	3.03 (0.03)
Thayer's	6.30 (0.47)
Biotène OB	6.61 (0.12)
Rain	7.10 (0.02)
Tap water	6.99 (0.13)
Citric acid	1.33 (0.09)

Reference: Delgado AJ, Olafsson VG, Donovan TE. pH and Erosive Potential of Commonly Used Oral Moisturizers. *J Prosthodont.* 2016 Jan;25(1):39-43.

TABLE 7

pH of Mouthrinses

Mouthrinse	pH
CTx4 Treatment Rinse	10.4
CTx3 Maintenance Rinse	8.33
TheraBreath Oral Rinse	8.20
ACT Anticavity Fluoride Mouthwash	7.95
Cepacol Mouthwash	7.79
PerioSciences AO ProRinse	7.75
OraCare	7.55
BreathRx Anti-Bacterial Tongue Spray	7.30
CB12 Mouthwash	7.20
Oxyfresh Mouthrinse	7.17
SmartMouth	7.11
CloSYS Rinse	7.10
Biotène Dry Mouth Oral Rinse	7.09
Colgate Optic White Mouthwash	6.95
CloSYS Alcohol-Free Oral Rinse	6.85
Oasis Moisturizing Mouthwash for Dry Mouth	6.49
Colgate Total Advanced Health Mouthwash	6.31
BreathRx Anti-Bacterial Mouth Rinse	6.21
BreathRx Anti-Bacterial Breath Spray	6.20
Colgate FluoridGard Daily Mouth Rinse	6.10
Listerine Zero Alcohol Mouthwash	6.02
ProFresh Chlorine Dioxide Oral Rinse	5.90
ACT Restoring Anticavity Fluoride Mouthwash	5.56
Scope Classic	5.55
Peridex	5.48
Listerine Total Care Mouthwash	5.44
Crest 3D White Multi-Care Whitening Rinse	5.40
Crest Pro-Health Clinical Rinse	5.18
Chlorhexidine Alcohol-Free	5.10
Fluoridex Daily Renewal Oral Rinse	5.10
Listerine Antiseptic Mouthwash	4.88
BreathRx Anti-Bacterial Rinse	4.74
Biotène Mouthwash	4.64
BreathRx Anti-Bacterial Mouth Spray	4.53
Healthy White Bleach Agent	4.50
Crest Pro-Health Multi-Protection Mouthwash	4.27
Peroxyl Antiseptic Oral Cleanser	3.90
Tom's of Maine Wicked Fresh! Mouthwash	3.89
The Natural Dentist Healthy Gums Mouth Rinse	3.30

Neutral = 7



Medication-Related Dental Erosion: Direct vs. Indirect Association

Direct Association

Medications with a pH of <5.5—which is the critical pH for enamel—may cause dental erosion. Other factors that influence the erosive potential of a substance are its titratable acidity, pKa value, chelation property, mineral content, and the time and frequency of acid contact. Various therapeutic medications or agents have the potential to cause erosive dental lesions due to their inherent acidity. These include the following:

- **Vitamin C and other oral supplements:** Supplemental vitamin C (L-ascorbic acid) can be dispensed as chewable tablets, syrups, or effervescent tablets. Prolonged use of vitamin C supplements, especially the chewable tablets, has been reported to cause severe dental erosion. Iron tonic and amino-acid supplements as well, have been implicated in tooth erosion.
- **Aspirin:** Prolonged use of chewable or powdered aspirin (acetylsalicylic acid) for the treatment of chronic pain has been shown to cause dental erosion. The contact time of this acidic medication with the teeth is prolonged when using chewable or powdered formulations. This, in turn, increases the risk for dental erosion.
- **Hydrochloric acid (HCl):** Preparations containing HCl, dispensed in tablet or liquid form, may be prescribed for patients with certain gastric disorders. These are known to cause erosion of teeth, especially when chewed or swished around, rather than immediately swallowed.
- **Asthma medications:** Though some investigators revealed no clear association between asthma and dental erosion, various other studies have shown that patients with asthma are at a heightened risk of developing dental erosion. The acidic nature of the medications used to control asthma has been implicated as a reason. It has been shown that many asthmatic drugs in current use (e.g., beclomethasone dipropionate, fluticasone, salmeterol, and terbutaline sulfate)—especially those delivered in the powdered form—have a pH less than the critical level of 5.5 required for the dissolution of hydroxyapatite. Although a study by Tootla et al (2004) demonstrated no clinically significant acidogenic response with the different inhalers tested, a fall in the salivary and plaque pH was seen with a lactose-based dry powder inhaler. Use of these agents multiple times in a day may erode the teeth they contact. The indirect association of asthmatic medications and dental erosion (reduced acid clearance and increased gastric reflux) will be discussed later.
- **Low-pH mouth rinses:** Some of the proprietary mouth rinses available for purchase by the general public are shown to be acidic. Results of a study that measured the erosive potential of various low-pH mouth rinses indicated that acidified sodium chlorite mouth rinse produced erosion similar to orange juice. In another in vitro study, an EDTA-containing anti-calculus rinsing solution exhibited dissolution of enamel after 2 hours of exposure due to the calcium-chelating action of EDTA. An essential-oil mouthwash (Listerine®, Johnson & Johnson, www.listerine.com) was shown in a longitudinal in vitro study using quantitative light-induced fluorescence to cause erosion compared to the negative control, but this was only significant after 14 hours of continuous use. This suggests that prolonged use of these low-pH oral rinses has the potential to cause dental erosion.
- **Liquid medications/pediatric syrups:** Numerous liquid oral medications/pediatric syrups prescribed by physicians have been shown to be acidic. When these acidic liquid medications are consumed for prolonged periods, as seen in cases of chronic diseases, they can cause dental erosive lesions. Acids—commonly citric acid—are in these medications for various reasons, including to maintain chemical stability, to control tonicity, to ensure physiological compatibility, and to improve flavor for patient acceptance.
- **Medications available in effervescent/dispersible form:** It has also been proposed that effervescent/dispersible tablets cause erosive tooth lesions, primarily due to their use of extra acid to promote the acid-based reactions that act to disperse effervescent and dispersible tablets on contact with water.
- **Acidic salivary substitutes/salivary flow stimulants:** Patients suffering from xerostomia may be advised to use either salivary flow stimulants or salivary substitutes. Salivary flow stimulants and artificial saliva with low pH and high titratable acidity can lead to dental hard tissue demineralization, especially in patients with reduced salivary protection.
- **Whitening/Bleaching agents:** Some bleaching agents available in the market have an acidic pH. This is mainly to avoid their degradation and thereby increase storage time. It was observed in an in vitro study that acidic bleaching agents resulted in significantly higher enamel hardness loss when compared to less acidic agents. The presence of saliva can eliminate the demineralization effect caused by low pH. Therefore, it is important to consider the bleaching agent's pH and composition, especially when treating patients with reduced salivary secretion. In addition, do not recommend toothbrushing for at least one hour following removal of bleach trays, merely rinse with water.

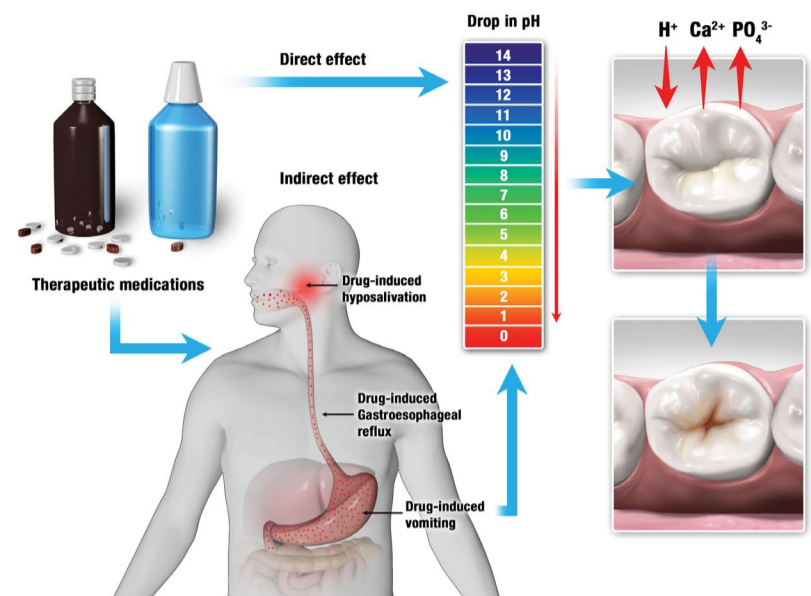


FIGURE 1 — Mechanism of drug-induced erosion.



Indirect Association

The medications that have the potential to cause erosion of the dental hard tissue secondary to their side effects are mentioned below:

- **Drug-induced hyposalivation:** Saliva plays an essential role in preserving the surface integrity of dental hard tissues. The protective role of saliva against dental erosion can be attributed to the following factors:
 - Dilution and clearance of erosive agents from the oral cavity
 - Buffering and neutralization of acids
 - Reduction of demineralization and enhancement of remineralization by the presence of calcium, phosphate, and fluoride ions
 - Formation of a protective diffusion barrier (acquired pellicle) on the tooth surface

Therefore, the medications that cause reduced salivary flow can put the patient at risk of tooth erosion by reducing the protective function of saliva against extrinsic as well as intrinsic acids. Some of the drugs associated with reduced salivation are alpha-receptor antagonists; anticholinergics; antidepressants (e.g., serotonin agonists or noradrenaline and/or serotonin re-uptake blockers); antipsychotics such as phenothiazines; atropinics; muscarinic receptor antagonists; HIV protease inhibitors; and antiasthmatic agents (beta-2 adrenoceptor agonists). An article on drug-induced dry mouth by Scully is a useful resource for additional details.

- **Drug-induced gastroesophageal reflux:** Drugs likely to cause gastroesophageal reflux disease can cause the intrinsic gastric acid to reach the oral cavity and thus increase the risk for dental erosion. Some examples of such medications include antispasmodic drugs (theophylline), antiasthmatic medications, anticholinergics, progesterone, and calcium channel blockers. For more information, refer to the article by Bartlett and Smith (1998).
- **Drug-induced vomiting:** Drugs that induce vomiting can also be considered an indirect cause of dental erosion. For example, abuse of ipecac syrup (an over-the-counter emetic) by bulimics can result in dental erosion. Similarly, patients undergoing cytotoxic chemotherapeutic drug treatment for malignancies may suffer from frequent vomiting, resulting in erosion. Thus, extended use of such drugs can cause dental erosion as a secondary side effect.

Reference:

Thomas MS, Vivekananda Pai AR, Yadav A Manuel S. Medication-Related Dental Erosion: A Review. *Compend Contin Educ Dent*. 2015 Oct;36(9):662-6.



- pH alone may be misleading because it is also related to the type of acid, see table below:

TABLE 9

Main Dietary Acids and Their Sources

Type of acid	Dietary Source
Acetic	Vinegar-containing foods, pickles, and some sauces
Ascorbic	Chewable Vitamin C tablets, some drinks
Carbonic	Carbonated drinks
Citric	Citrus juices and fruits
Malic	Apple and apple juice
Oxalic	Rhubarb
Phosphoric	Soft Drinks (eg, cola drinks)
Tartaric	Grapes and Grape Juice, Wine

Reference: Auad S, Moynihan P. Diet and dental erosion. *Quintessence Int.* 2007 Feb;38(2):130-3.

- Certain acids chelate calcium, making the enamel surface more vulnerable to erosion, see tables below:

TABLE 10

Enamel Dissolution in Various Beverages

Beverage	Container	pH	14-day weight loss (%)	14-day weight loss (mg/cm)
Coca-Cola	Bottle	2.48	1.39 ± 0.34	2.78 ± 0.71
Diet Coca-Cola	Bottle	3.22	1.49 ± 0.29	3.07 ± 0.06
Pepsi-Cola	Can	2.46	1.40 ± 0.22	3.31 ± 0.43
Diet Pepsi-Cola	Can	2.94	1.46 ± 0.23	3.22 ± 0.26
Dr. Pepper	Bottle	2.90	1.72 ± 0.36	3.21 ± 0.24
Diet Dr. Pepper	Bottle	2.99	1.52 ± 1.00	2.99 ± 1.24
Mountain Dew	Bottle	3.14	6.17 ± 1.13	14.31 ± 0.94
Diet Mountain Dew	Bottle	3.27	8.01 ± 1.46	14.82 ± 2.23
Sprite	Can	3.27	3.93 ± 1.30	8.60 ± 1.94
Diet Sprite	Can	3.34	3.65 ± 1.27	6.43 ± 0.37
Canada Dry Ginger Ale	Can	2.94	3.48 ± 0.71	6.31 ± 0.65
A&W Root Beer	Can	4.80	-0.01 ± 0.12	-0.03 ± 0.28
Arizona Iced Tea	Can	2.94	4.86 ± 0.59	9.03 ± 1.21
Brewed Black Tea	N/A	5.36	0.22 ± 0.07	0.35 ± 0.12
Brewed Black Coffee	N/A	6.25	0.19 ± 0.03	0.34 ± 0.03
Tap Water (Control)	N/A	6.70	-0.02 ± 0.08	-0.05 ± 0.13

Reference: von Fraunhofer JA, Rogers MM. Dissolution of dental enamel in soft drinks. *Gen Dent.* 2004 Jul-Aug;52(4):308-12.

TABLE 11

Means and Standard Deviations of the Physiochemical Properties of Sports and Energy Drinks

Sports Drinks	Mean ± Standard Deviation		
	Fluoride (ppm)	pH	Titrateable Acidity* (mL of 1.0 M NaOH)
Propel Grape	0.20 ± 0.01	2.98 ± 0.09	3.11 ± 0.02
Powerade Option	0.06 ± 0.00	2.78 ± 0.07	3.03 ± 0.03
Gatorade Rain	0.36 ± 0.03	3.08 ± 0.02	3.32 ± 0.01
Powerade White	0.12 ± 0.02	2.76 ± 0.02	3.63 ± 0.15
Powerade Blue	0.12 ± 0.01	2.86 ± 0.03	3.60 ± 0.10
Powerade Red	0.08 ± 0.01	2.77 ± 0.01	3.50 ± 0.10
Powerade Advance	0.11 ± 0.02	2.77 ± 0.02	3.83 ± 0.25
Propel Mango	0.78 ± 0.07	3.23 ± 0.03	2.93 ± 0.06
Fuze	0.57 ± 0.08	3.09 ± 0.02	3.37 ± 0.21
Thirst Quencher	0.05 ± 0.01	2.85 ± 0.02	3.77 ± 0.06
Speedo	0.79 ± 0.09	3.06 ± 0.37	3.27 ± 0.06
Gatorade Blue	0.05 ± 0.01	2.92 ± 0.03	4.83 ± 0.06
Hydr8	0.35 ± 0.05	2.69 ± 0.01	4.40 ± 0.10
Energy Drinks			
Red Bull	0.42 ± 0.02	3.37 ± 0.06	10.79 ± 0.66
5-Hour Energy	0.14 ± 0.00	2.81 ± 0.01	13.73 ± 0.36
MDX	0.03 ± 0.00	2.70 ± 0.06	5.93 ± 0.38
Full Throttle Fury	0.16 ± 0.10	2.94 ± 0.01	9.83 ± 0.32
Rip It	0.39 ± 0.13	3.25 ± 0.01	10.13 ± 0.61
Red Bull Sugar Free	0.28 ± 0.09	3.27 ± 0.01	13.43 ± 0.86
Monster Assault	0.02 ± 0.01	3.49 ± 0.01	13.63 ± 1.38
Von Dutch	0.03 ± 0.01	3.10 ± 0.01	14.03 ± 0.50
Rockstar	0.005 ± 0.00	2.53 ± 0.01	14.53 ± 0.45

*A higher number means that the drink is more corrosive.

Reference: Jain P, Hall-May E, Golabek K, Agustin MZ. A comparison of sports and energy drinks--Physiochemical properties and enamel dissolution. *Gen Dent.* 2012 May-Jun;60(3):190-7.