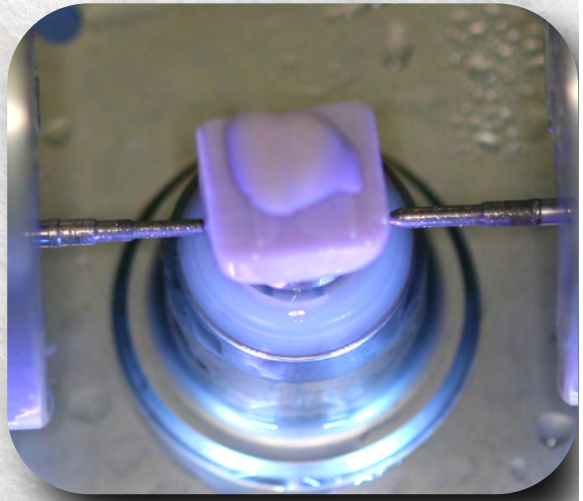
CAD/CAM Dentistry: It's Your Future

Computer Assisted Design (CAD)
Computer Assisted Machining (CAM)

- Computer Surface Digitization
  - 3-D Data Acquisition
  - Record geometry of the tooth



- Restoration Design (CAD)

  Create new mathematical object (restoration) on the tooth model with software program

- Manufacturing (CAM)

  Automated subtractive milling process to cut the restoration from a manufactured block of porcelain

Why the interest in CAD/CAM?

- Recent market demand has significantly increased the need for quantity and quality of ceramic restorations
  - Predictable, repeatable results through automation
- Advanced materials capability – new materials available only through CAD/CAM technology
  - Improved consistency through industrial fabrication
- Reduces production time and costs
  - Automated process replaces many handcrafted processes
  - Machines do not require training and do not get bored

What can CADCAM be used for?

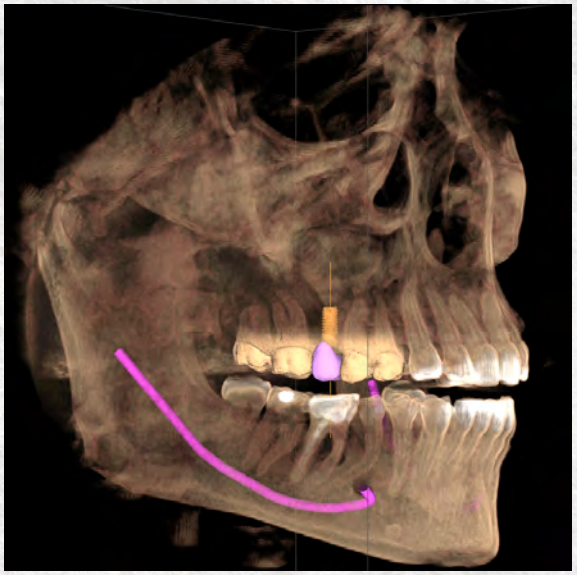
- Tooth-born restorations
  - Crowns, Onlays, Inlays, Bridges
- Implant abutments & restorations
- Digital impressions sent to lab
  - Gold crowns
  - Zirconia Crowns and Bridges

What can CADCAM be used for?

- **Clear Aligner Orthodontics**
  - **Invisalign**
  - **Clearcorrect**
- **Nightguards**
  - **Great Lakes Ortho**
  - **Glidewell**

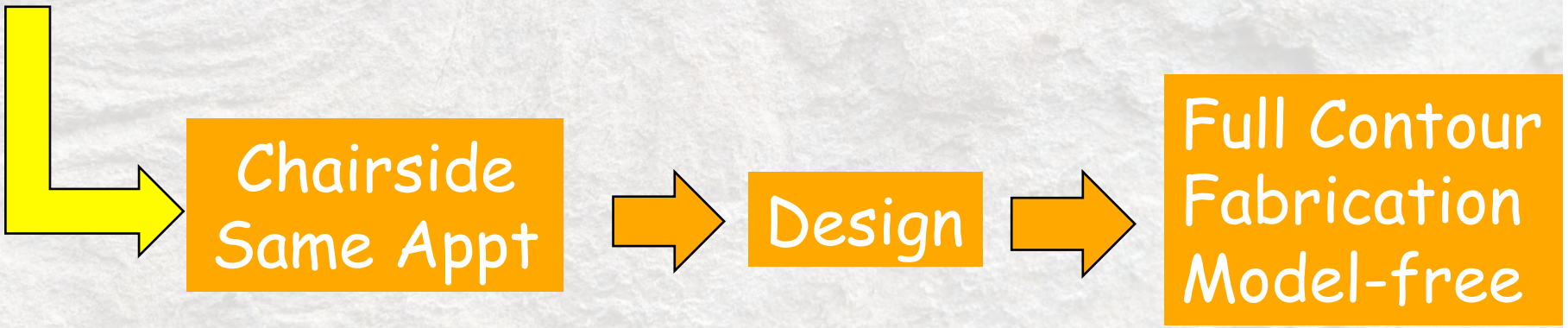
What can CADCAM be used for?

- **Guided implant surgery**
  - **Can mill guides with MCXL**
  - **Plan case with CBCT (cone beam computerized tomography) and large case guides**



Digital Dentistry – In-office Options

Imaging

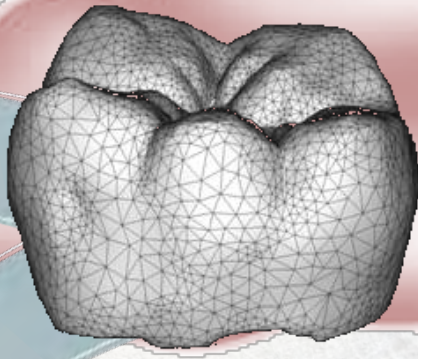


Open Architecture

3M ESPE Lava
Lab Network

3M ESPE
Authorized
Lava™
Milling Center

Data File



Data File

E4D

Chairside
Milling

BIOMET 3i™

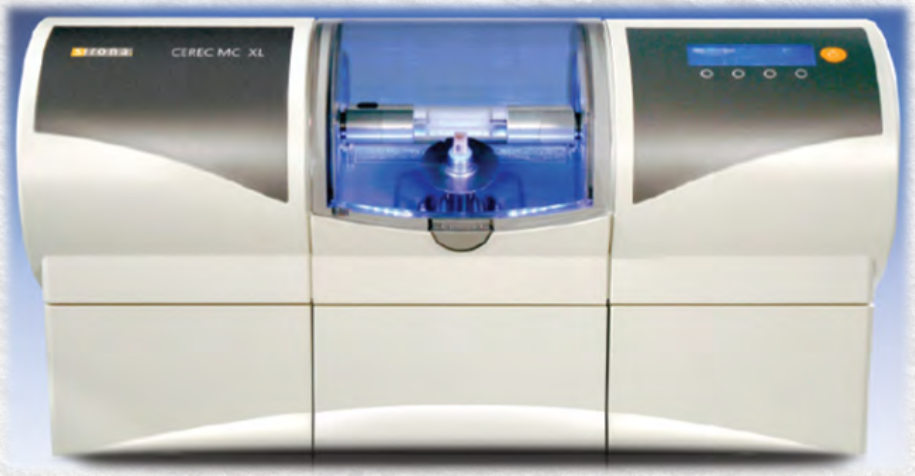
Implant
Workflows

Closed Architecture

- CAD/CAM process completed totally within equipment from a single manufacturer

CEREC System

CEramic REConstruction



Chairside CAD/CAM

Management of entire workflow in the office
Increased productivity for the practice
No temporaries, No impressions
Improved restorative materials

E4D (D4D Tech)
2008

CEREC AC (Sirona)
1985

Pre-op

Pre-op

Preparation

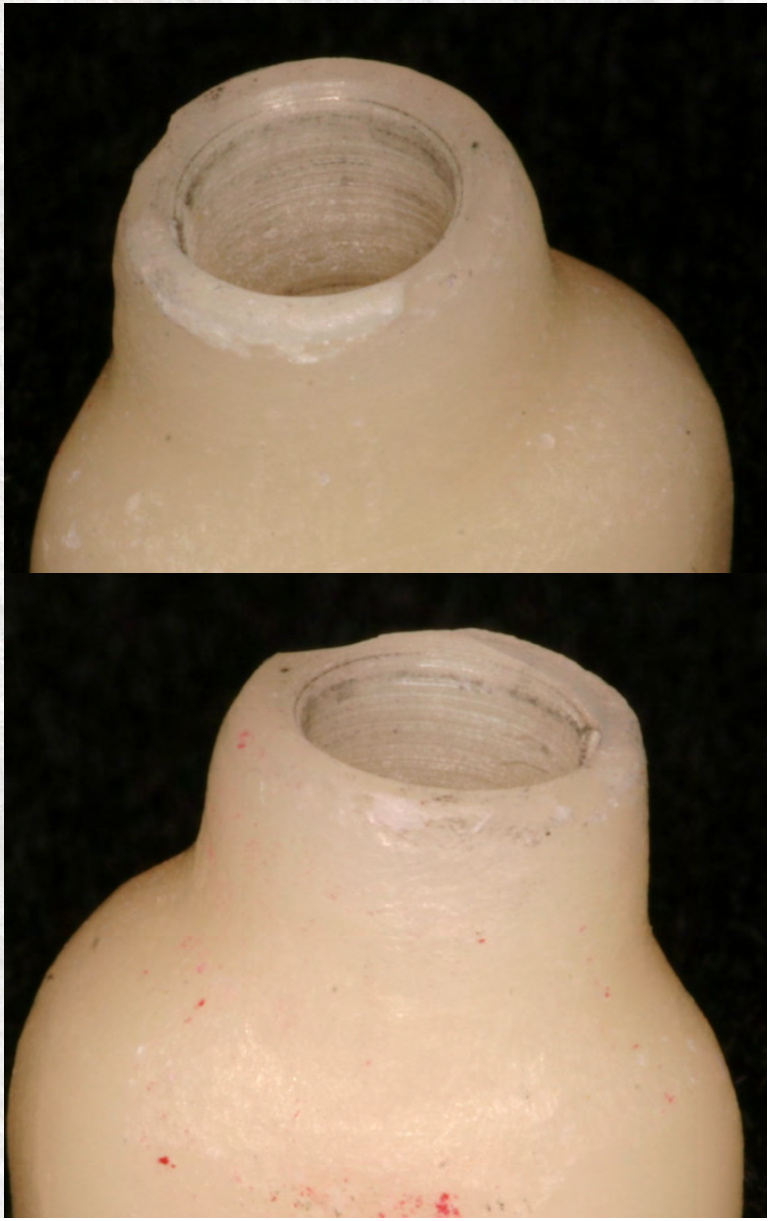
Preparation

Blue stage try-in

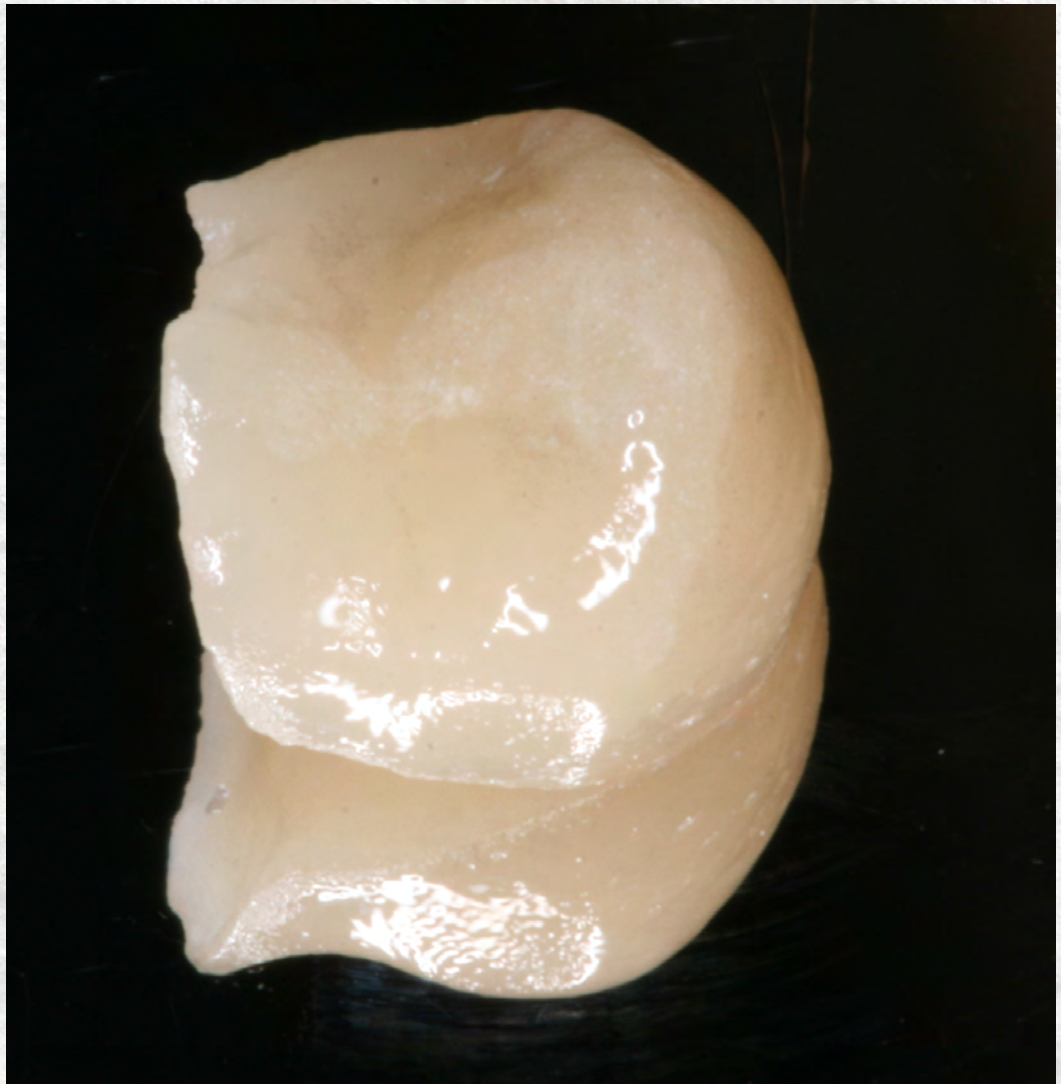
lithium disilicate

Blue stage drop on floor, then fired

not going to work



Final restoration



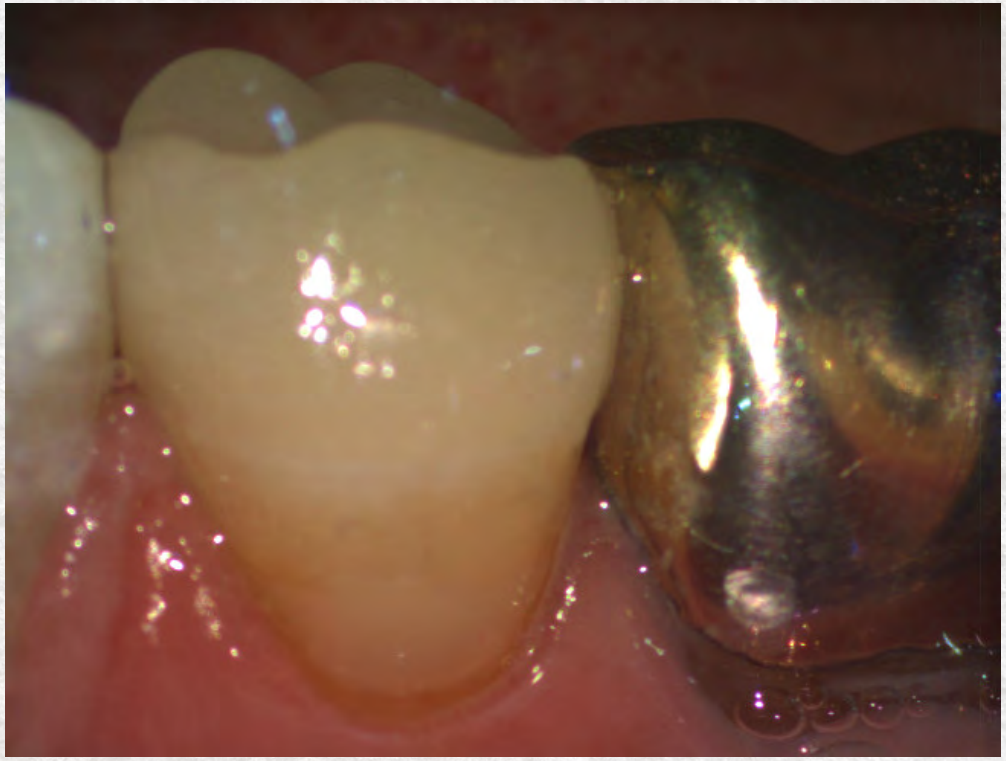
Final

Final

Overview

- Advantages
- Disadvantages
- Indications
- Preparation
- Imaging
- Design
- Milling
- Cementation
- Maintenance

Advantages/Disadvantages/Indications



Advantages

- Esthetics
- Color stability
- Wear resistance
- Excellent tissue response
- Conservation of Tooth Structure?
- Reinforce Tooth Structure (short term)
- Low Thermal Conductivity
- Single appointment:
  - Reduced time
  - No provisional
  - Reduced post-op sensitivity
  - Improved bonding

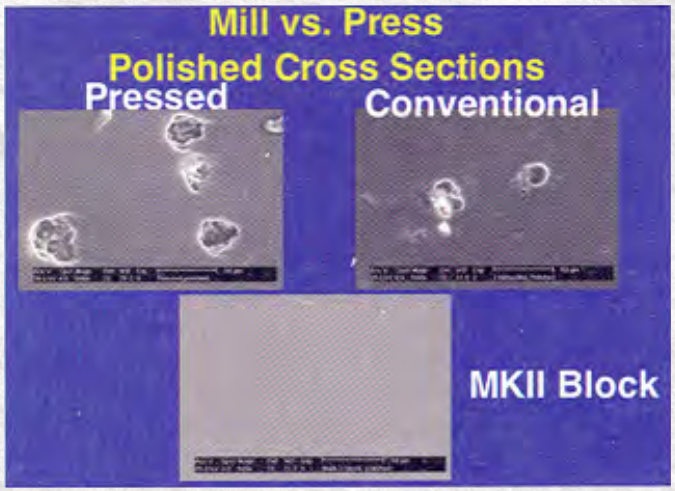
adhesive is more conservative; can maintain cusps in image below. ACC req lots of reduction to have enough material and for draw

best substrate is freshly cut tooth structure

Advantages

Rationale for superior properties of CAD/CAM materials:

- Improved reliability due to reproducible manufacturing
- Dense material nearly devoid of pores

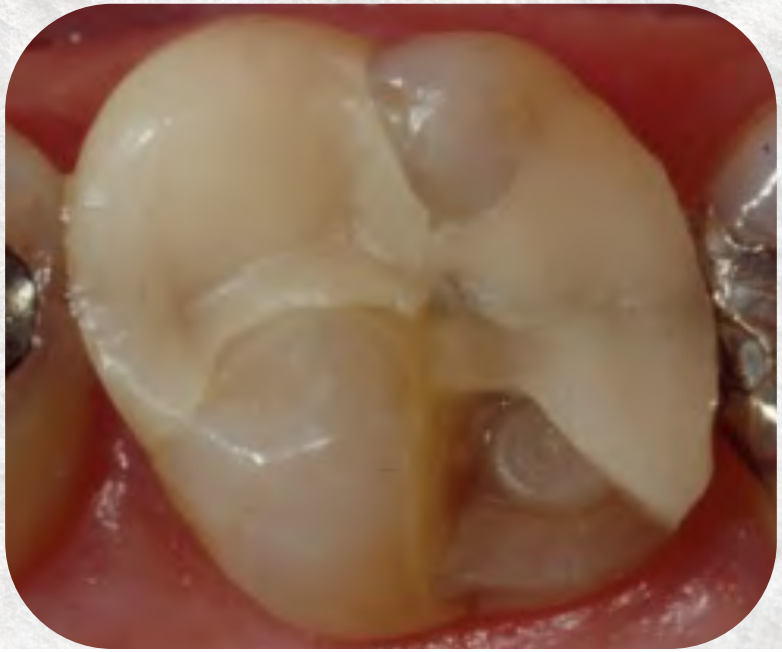


CAD CAM block no voids

"CEREC ceramics represent the highest quality materials in each microstructure category." Kelly JR (2006). Machinable Ceramics. In: In Mörmann WH (ed.) *State of the Art of CAD/CAM Restorations. 20 Years of CEREC*, Berlin, Quintessenz Verlags-GmbH,pp 29-38.

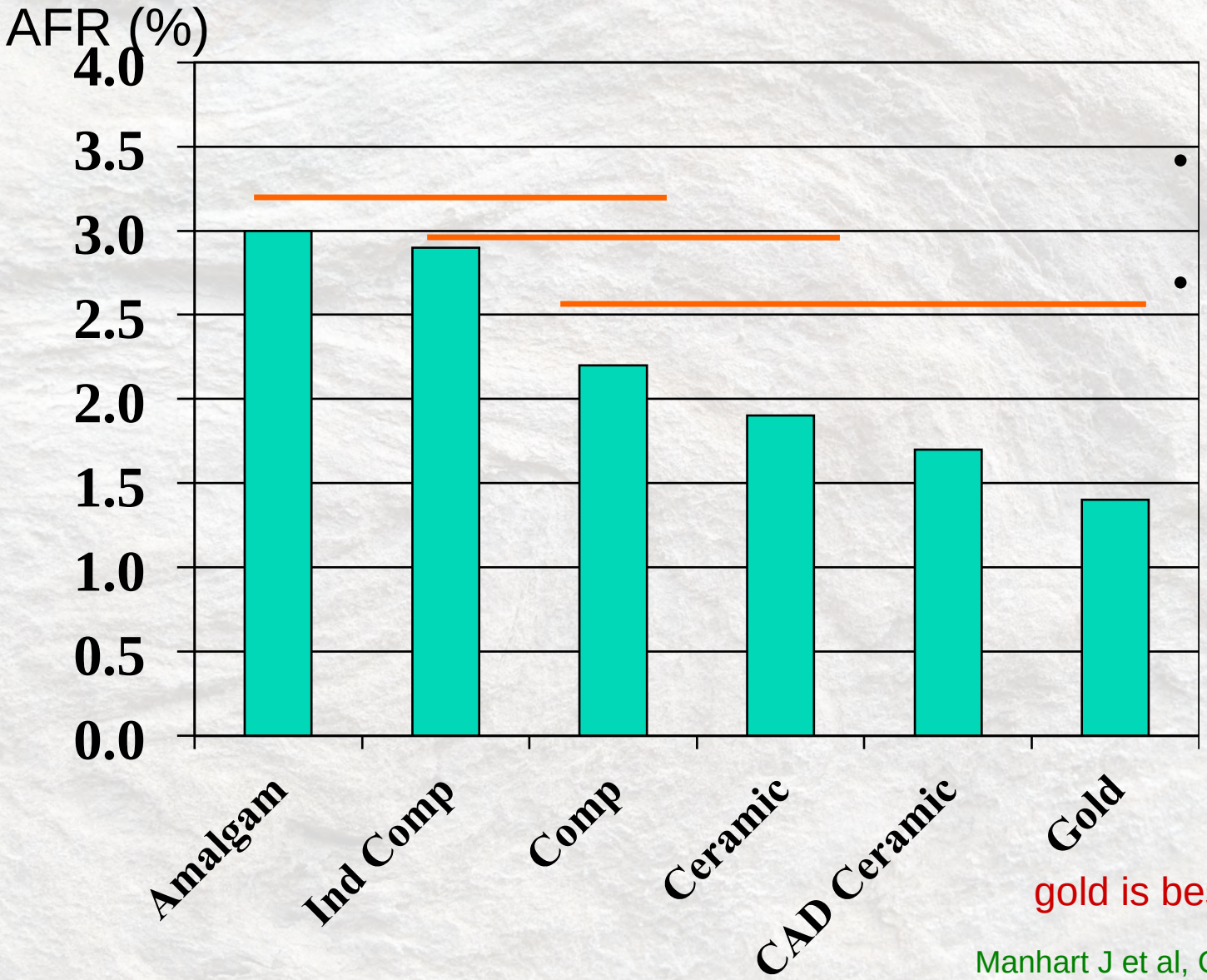
Disadvantages similar to any all ceramic

- Increased wear of opposing dentition
- Restoration fracture
- Prep design lots of reduction for adequate thickness of material and adequate taper for seating
- Custom shading by staining only (CADCAM)



Study	Porcelain Type	Inlay/Onlay	Duration	Annual Failure Rate
Kramer & Frankenberger, 2005	Empress	Both	8 Years	1%
Arnelund et al, 2004	Feldspathic & Empress	Both	5 Years	1.6%
Sjogren et al, 2004	CEREC	Inlay	10 Years	1.1%
Schulz et al, 2003	Feldspathic	Inlays	9 Years	1.8%
Posselt & Kerschbaum, 2003	CEREC	Inlays	9 Years	0.5%
Otto & DeNisco, 2003	CEREC	Both	10 Years	1%
Palleson & van Dijken, 2000	Feldspathic	Inlays	8 Years	0.9%
Hayashi et al, 2000	Feldspathic	Inlays	8 Years	2.5%
Molin & Karlsson, 2000	CEREC, Empress, Feldspathic Gold	Inlays	5 Years	1.6% 0%
Wagner et al, 2004	Empress I	Onlays	7 Years	2.7%
Fassbinder et al, 2010	CEREC (eMax)	Crowns	2 Years	0%
Federlin et al, 2010	CEREC Gold	Onlays	5.5 years	2% 1.2%
Wagner et al, 2004	Gold	Onlays	7 Years	0.6%
Donavan et al, 2004	Gold	Both	39 Years	0.07%

Longevity of Posterior Restorations



- Review of 193 clinical studies
- Columns connected with horizontal line are stat equal

gold is best, then CAD

Manhart J et al, Oper Dent 29:481 (2004)

Trends in Porcelain Inlay/Onlay Clinical Studies

- Very good patient satisfaction (Kramer & Frankenberger, Dent Mater 21:262 [2005]; Sjogren G et al, Int J Pros 17:241 [2004]; Otto T et al, Int J Pros 15:122 [2002])
- Primary cause of failure is restoration bulk fracture (Hayashi M et al, Oper Dent 25:472 [2000]; Kramer & Frankenberger, Dent Mater 21:262; 2005; Kramer & Frankenberger, Dent Mater 21:262; 2005)
- Marginal degradation, including marginal fractures/ditching, increases with time (Hayashi M et al, Oper Dent 25:472 [2000]; Kramer & Frankenberger, Dent Mater 21:262; 2005; Molin & Karlsson, Int J Pros 13:194 [2000]; Otto T et al, In J Pros 15:122 [2002])

  gap btw restorations and prep -> filled with cement -> unsupported porcelain susceptible to crack initiation

Trends in Porcelain Inlay/Onlay Clinical Studies

- Onlays tend to perform better than inlays (Arnelund et al, In J Pros 17:302 [2004]; Otto T et al, In J Pros 15:122 [2002]; Magne & Belser, Int J Pros 23:543 [2003])
  - Get margins off the occlusal surface
  - Best stress distribution with onlay prep using rounded shoulder margins Kejak B et al, JPD 98:89 (2007)
- Porcelain inlays/onlays perform worse in bruxers/ clenchers because fracture is primary failure cause (Schulz P et al, Int J Pros 16:510 [2003]; Otto T et al, In J Pros 15:122 [2002])
- 3-7% will require endo (Otto T et al, In J Pros 15:122 [2002]; Smales & Etemadi, JPD 91:548 [2004]; Sjogren G et al, Int J Pros 17:241 [2004]; Kramer & Frankenberger, Dent Mater 21:262 [2005];)
- Premolars tend to perform better than molars (Arnelund et al, In J Pros 17:302 [2004]; Smales & Etemadi, JPD 91:548 [2004])
  less occlusal function on premolars; we prep these better generally bc improved visibility

Trends in Porcelain Inlay/Onlay Clinical Studies

- The “gold standard” is…. Gold

  (Molin & Karlsson, Int J Pros 13:194 [2000]; Manhart J et al, Oper Dent 29:481 [2004])

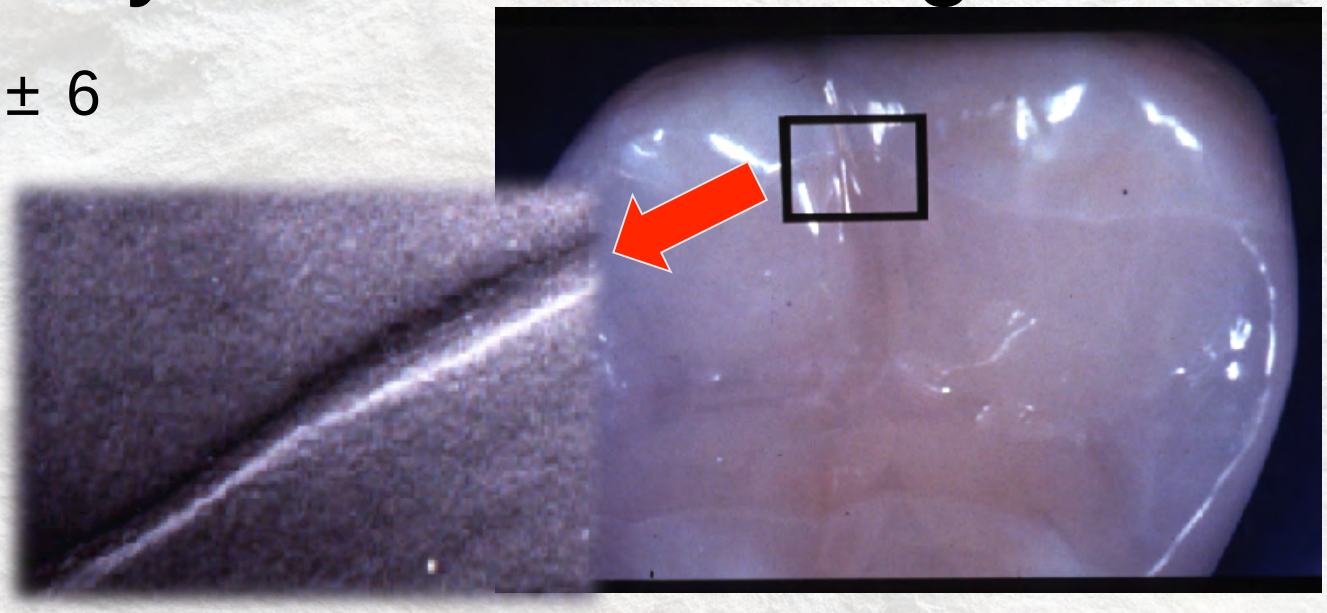
- Indications, preparation design (maintaining minimum porcelain thickness), bonding technique more important than materials, including metal reinforcement (Arnelund et al, In J Pros 17:302 [2004]; Smales & Etemadi, JPD 91:548 [2004] (Molin & Karlsson, Int J Pros 13:194 [2000]; Palleson & van Dijken, Eur J Oral Sci, 108:239 [2000]; Arnelund et al, In J Pros 17:302 [2004]; Coelho Santos M et al, Oper Dent 29:123 [2004])

Indications

- Start with gold, and move away only as patient or clinical situation dictates
- Patient not a bruxer/clencher
- Esthetic, cuspal coverage restoration indicated (ie onlay or crown, not an inlay)
- Crown that might otherwise be a PFM but where patient's function is not excessive
- It will be possible to do the restoration in a more conservative manner than a full crown (e.g. not all cusps need to be covered, or a "crownlay")
- Short clinical crown would make it difficult to achieve adequate resistance/retention with a conventional crown
- Esthetic restoration of occlusal surface indicated in conjunction with facial veneer.

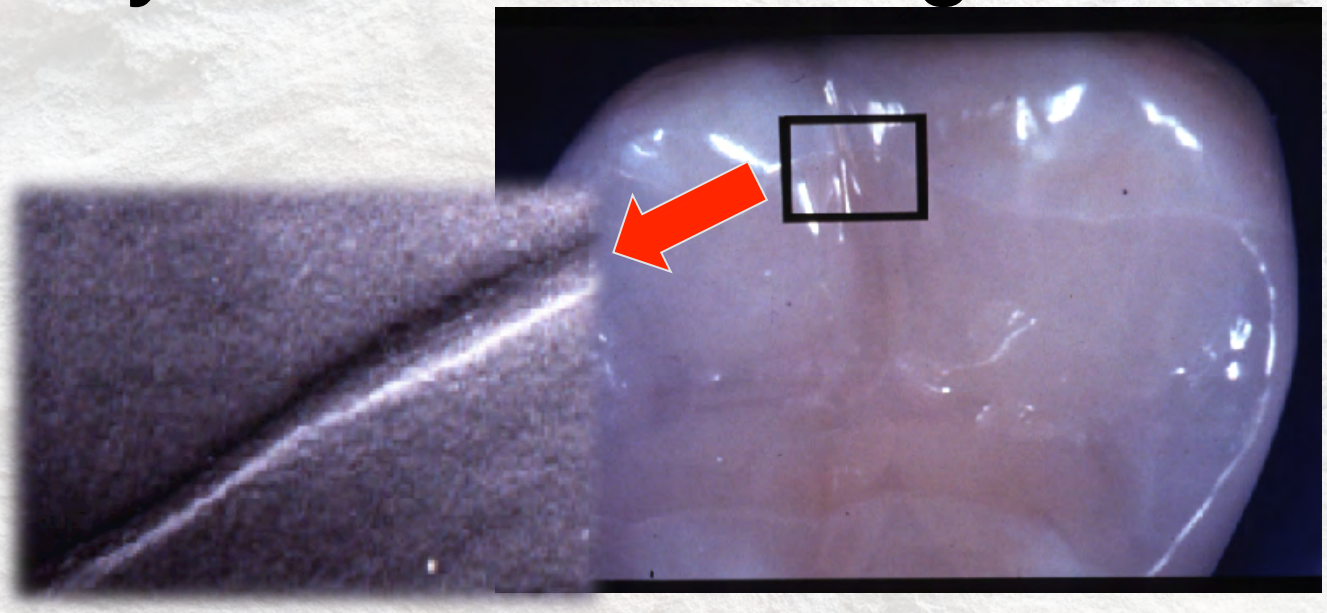
Accuracy of CEREC Marginal Fit

CEREC AC: 58 ± 6 µm



- CEREC restorations have margin adaptation equal to or better than laboratory made restorations.
  Christensen, CRA Newsletter 18 (5): 1,2, insert 1994
- Average marginal luting width of CEREC restorations is 50 µm (std dev = 15 µm)
  Jedynakiewitz, Dent Mater 2000 16 (1):68-74
- The marginal fit of inlays milled by the CEREC III was more accurate than the fit of those milled by the CEREC II, although both were within the ADA specifications of 50 µm. Estefan, General Dentistry, 2003 Vol. 51 No. 53
- CEREC AC has equivalent margin fit to CEREC 3.
  Cook K et al: CEREC Crown Fit Using Infrared Laser Camera and LED Camera. CEREC 25, Aug 2010

Accuracy of CEREC Marginal Fit



- Systematic review with meta analysis
- Average marginal discrepancy:
  - In vitro digital: 63um
  - In vitro elastomeric: 59um
  - In vivo digital: 56um
  - In vivo elastomeric: 79um
  - No significant difference between digital & elastomeric in vitro or in vivo Tsirogiannis P et al, JPD 116:328-335 (2016)