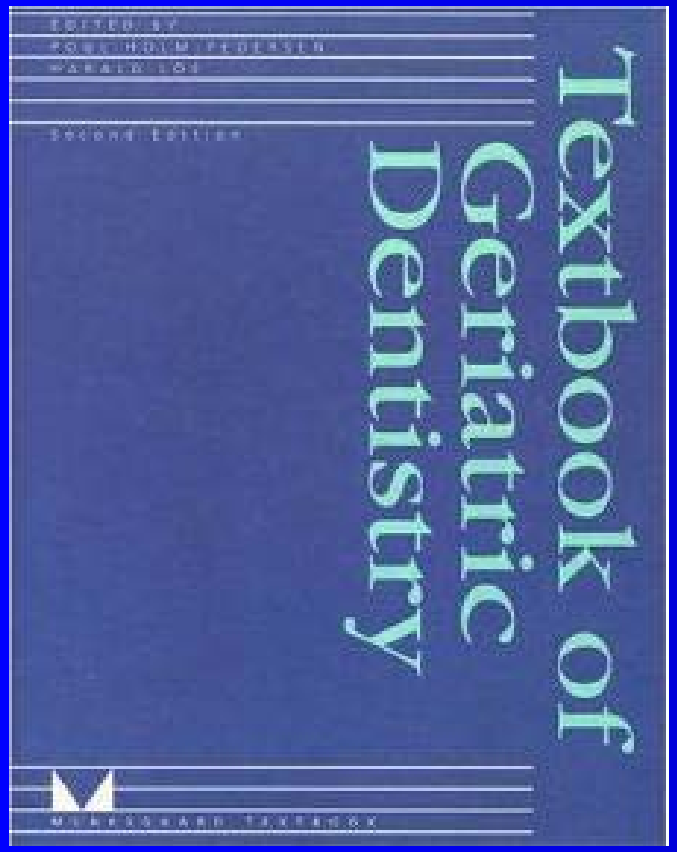
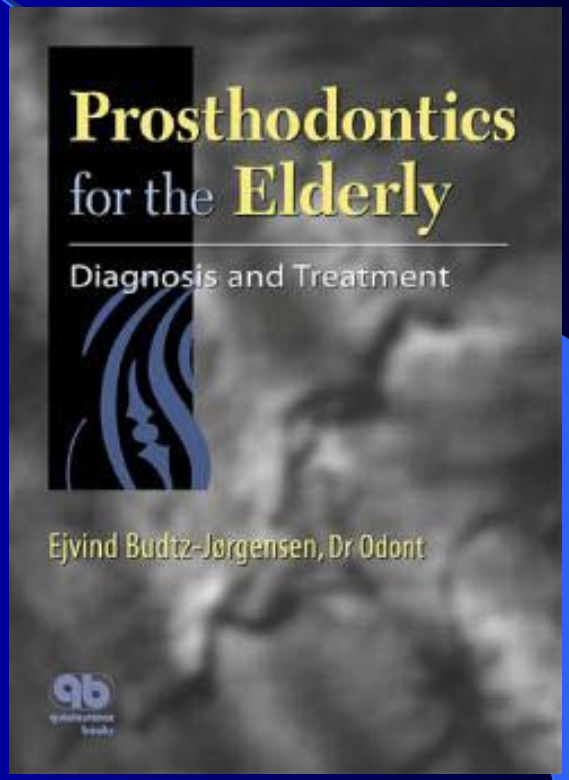
Anatomical and Physiological Changes of the stomatognathic system- Adulthood to Senescence

Asbjorn Jokstad, DDS, PhD
Professor, Prosthodontics

For further reading

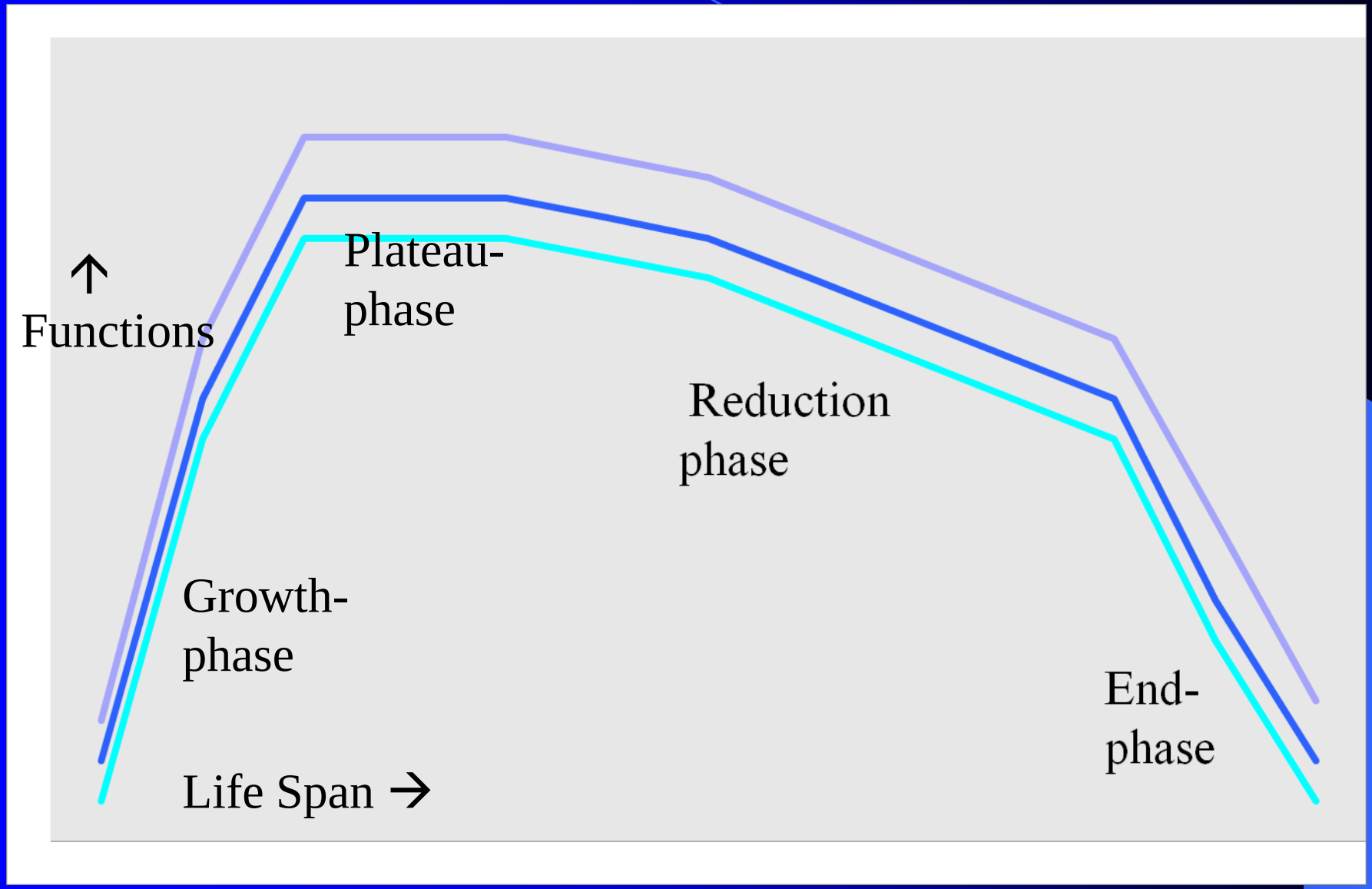
Holm-Pedersen P & Löe H. Textbook of Geriatric Dentistry. Munksgaard Publishing. 1st ed. 1986, 2nd 1993, 3rd 1997, 4th 2011



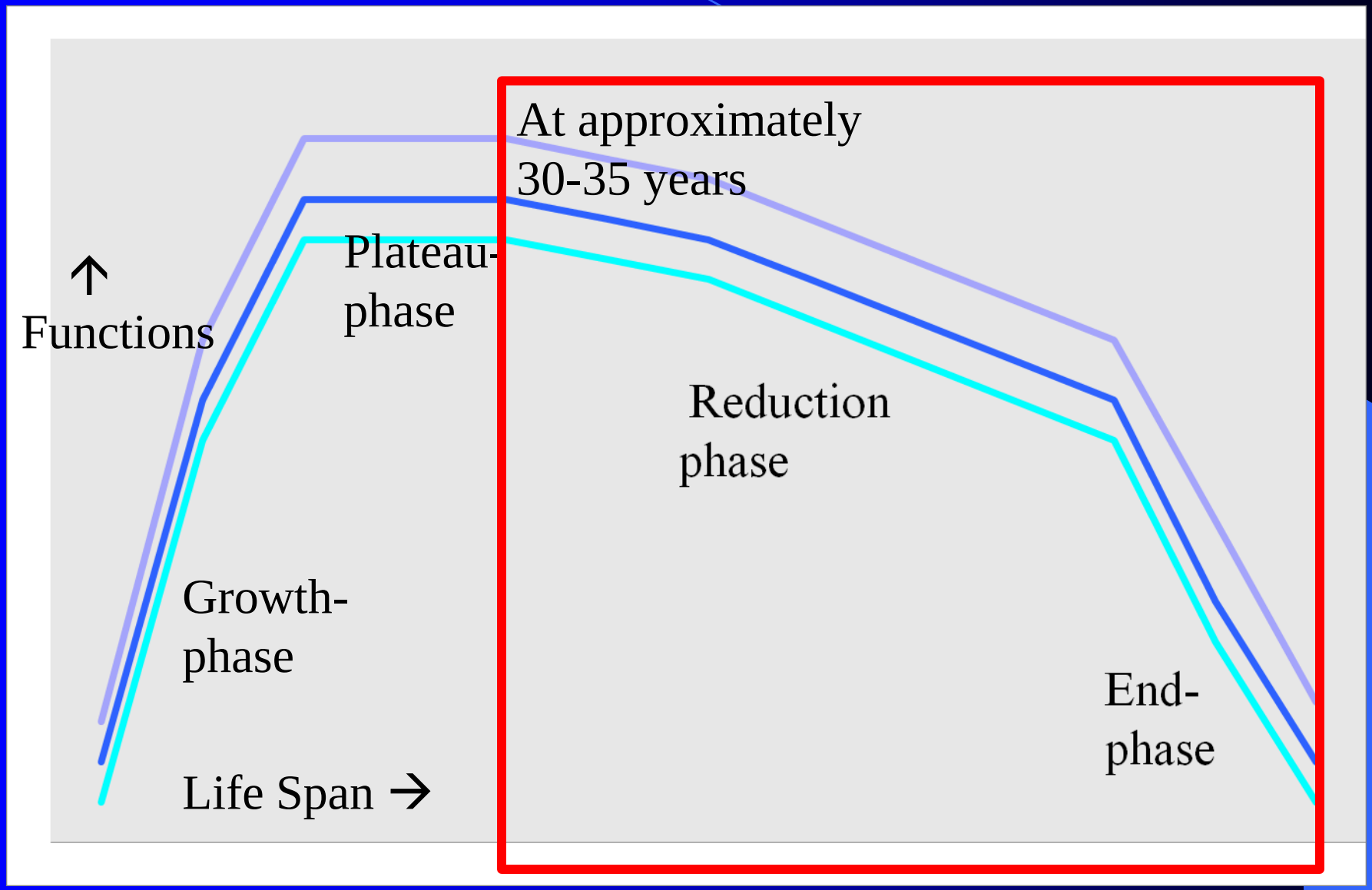


Budtz-Jørgensen E . Prosthodontics for the Elderly. Diagnosis and Treatment. Quintessence Publ. 1999

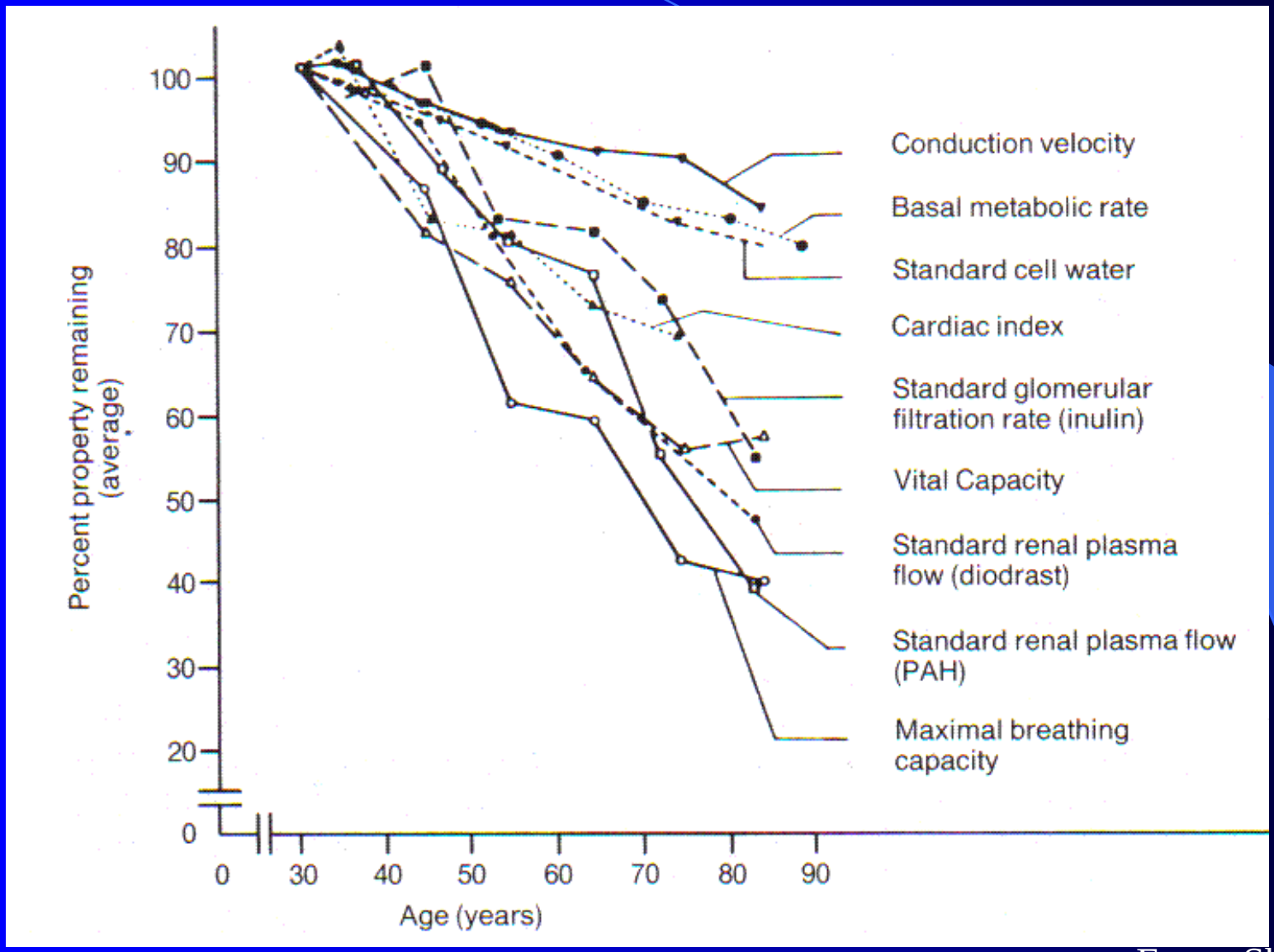
Human Physiologic Functions and changes with Age



Human Physiologic Functions and changes with Age

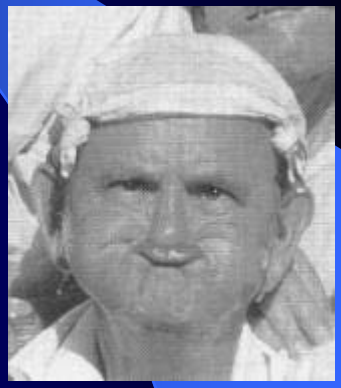


Reduction of physiological functions from age ~30
(based on data from cross-sectional studies)



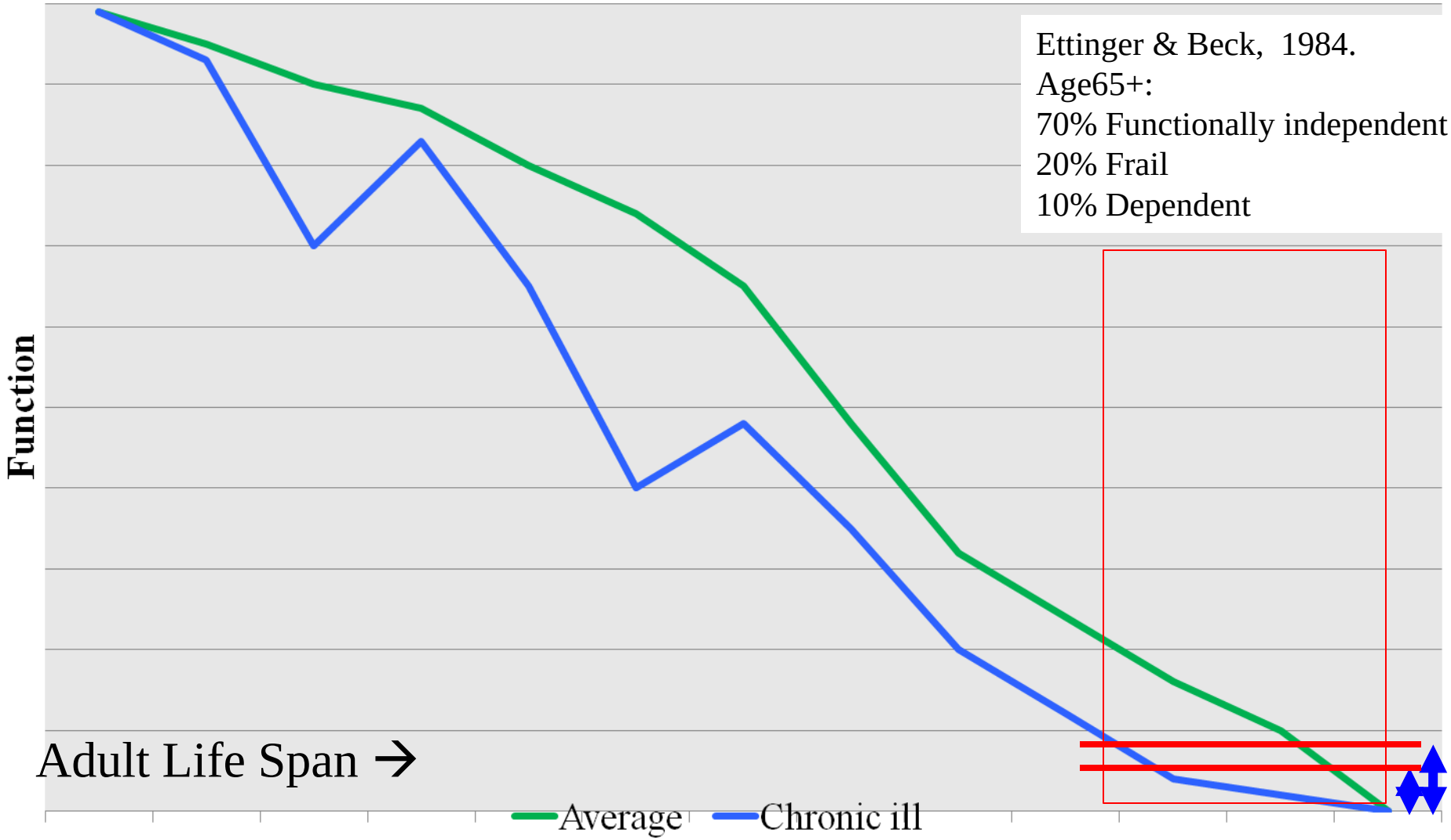
From: Shock 1962

Stereotype beliefs about elders' teeth

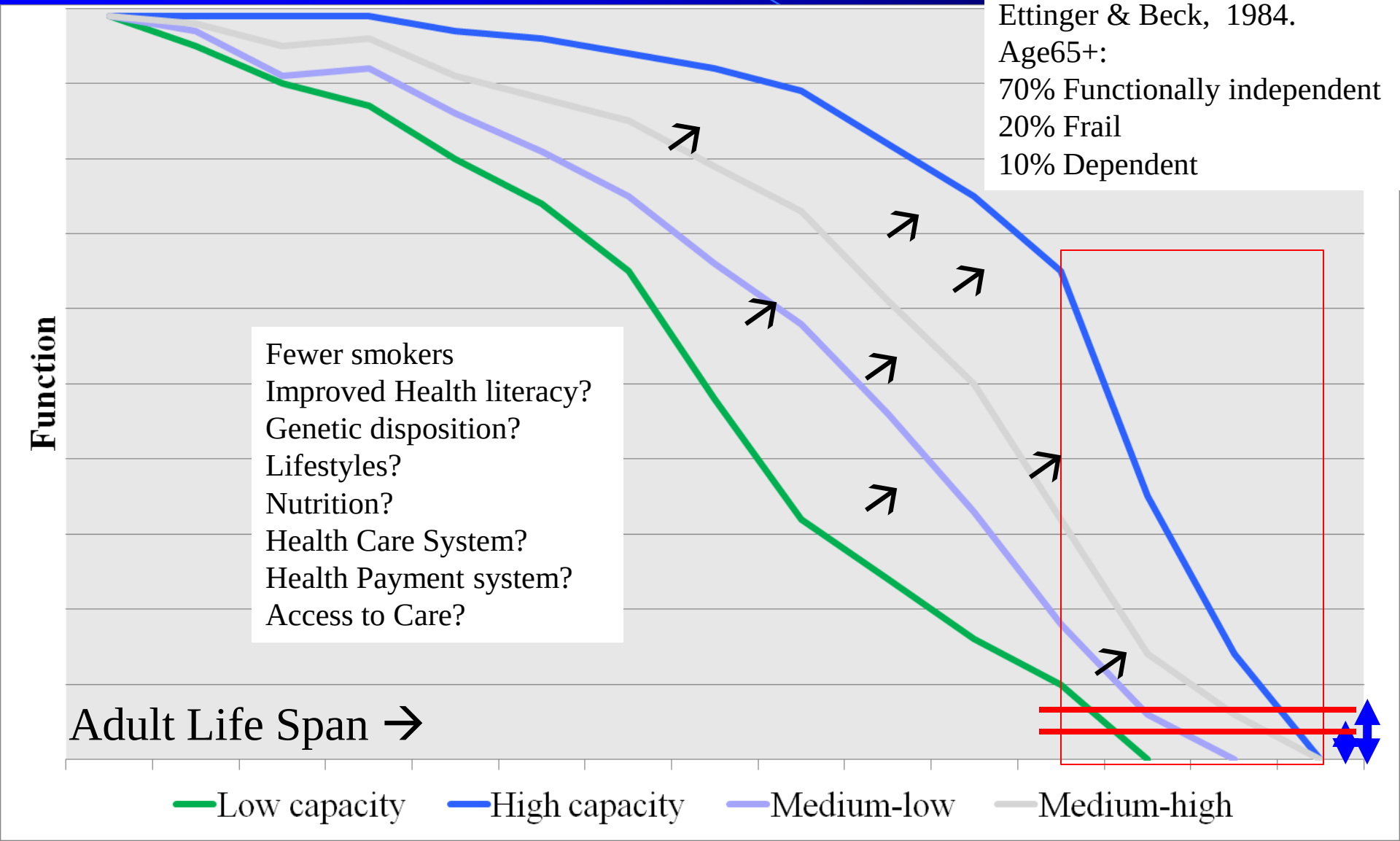


"Become long in the tooth"

Reduction of human physiologic functions from age 30 ~1960 situation



Reduction of human physiologic functions from age 30 – individual variations in modern society

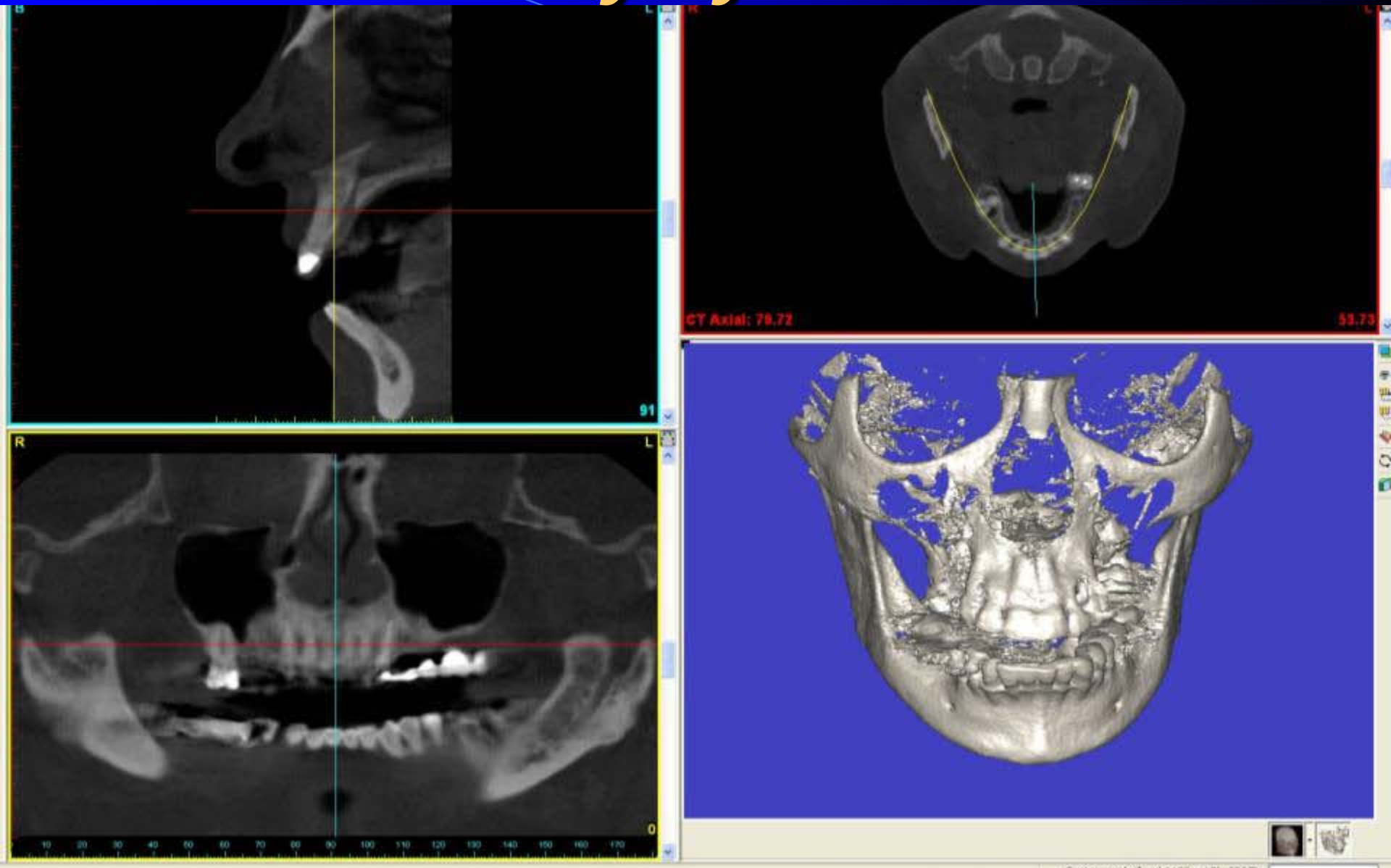


Anatomical and Physiological Changes of the stomatognathic system

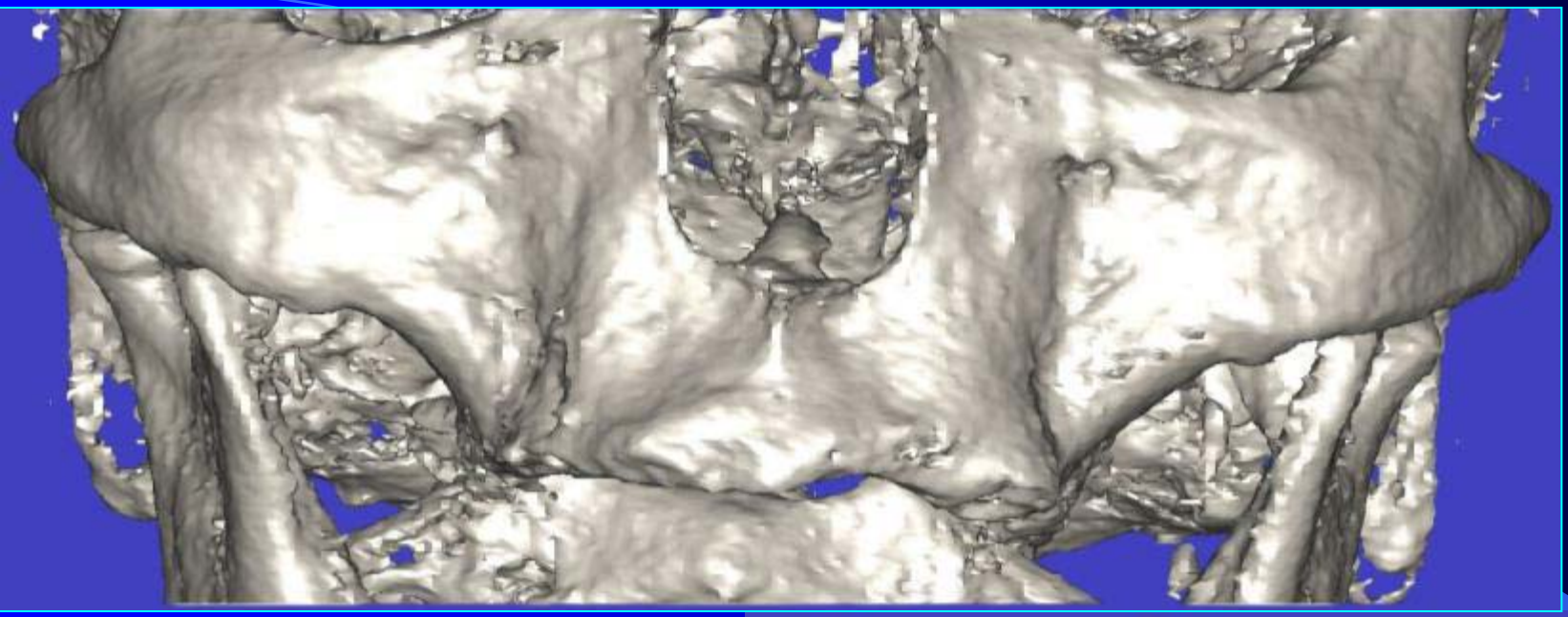
ANATOMY	PHYSIOLOGY
Bone	Quality and quality
Nerves and muscles -	Neuromuscular Functions: Chewing –Speech – Swallowing - Reflexes
Temporomandibular joint	Arthrosis
Salivary glands	Saliva quality and quality
Skin and oral mucosa	Atrophy
Dentition	Tribological phenomena (wear-)
Perio- and endodontium	Neurovascular & cellular changes
Systemic Conditions	Manifestations
Pathogenic environment*	Biofilm-induced oral diseases

*ADDITIONAL DIMENSIONS ARE: COMORBIDITY / MULTI-MEDICATION / NUTRITION / SLOWNESS / COGNITIVE IMPAIRMENT / HEARING LOSS

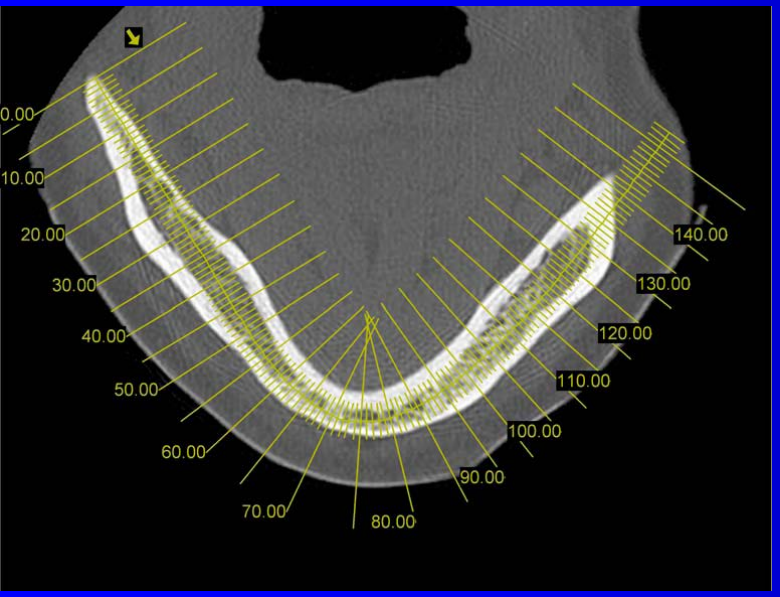
Bone - a very dynamic tissue!

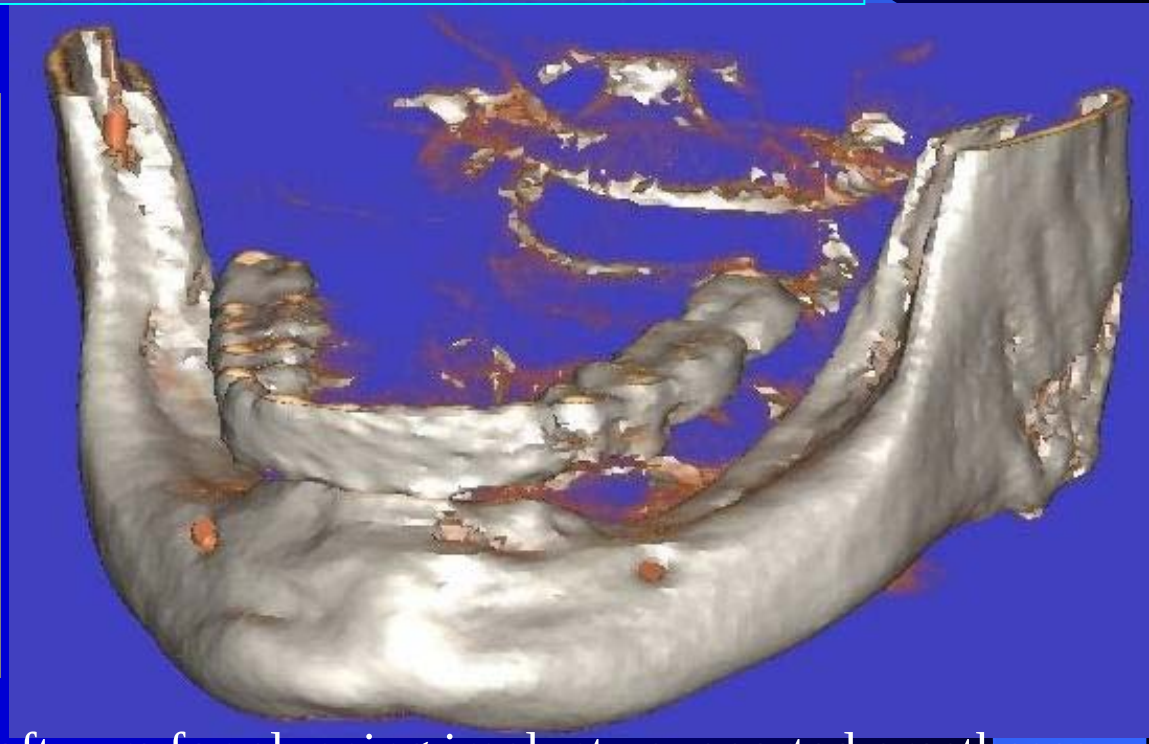


Example of computer-assisted software for planning implant –supported prostheses



Bone - a very dynamic tissue!





Examples of computer-assisted software for planning implant –supported prostheses

Bone quality and quantity

- Adult peak bone mass is attained by ~35 yr
- Mandibular bone density reduces ~20% between 45 and 90 years, women have lower values
- Bone becomes more brittle, with increasing microfractures of trabeculae
- Bone mass declines with age -both cortical and trabecular. Individual marked variations
- In elderly, bone turnover is reduced; with osteoclastic >> osteoblastic activity

Lekholm&Zarb “Bone quality index”

Bone quality and quantity

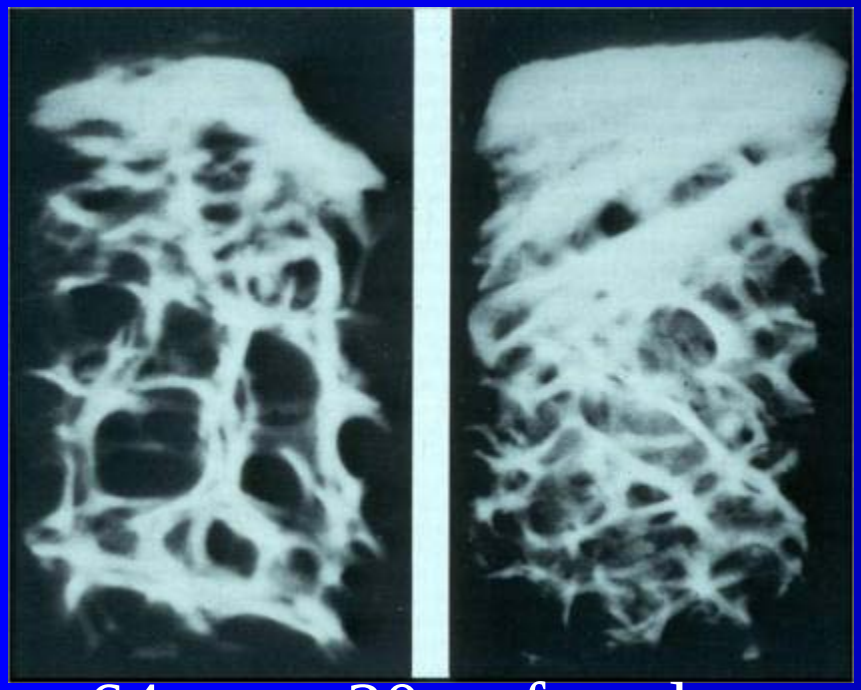
Adult peak bone mass is attained by ~35 yr

Mandibular bone density reduces ~20% between 45 and 90 years, women have lower values

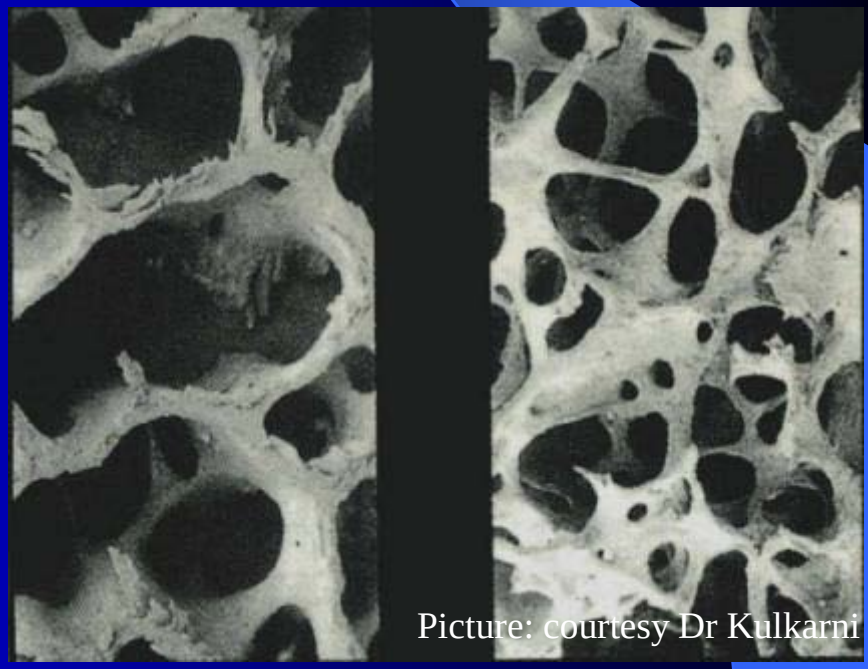
Bone becomes more brittle, with increasing microfractures of trabeculae

Bone mass declines with age -both cortical and trabecular. Individual marked variations

In elderly, bone turnover is reduced; with osteoclastic >> osteoblastic activity



64 yr vs 30 yr female



Picture: courtesy Dr Kulkarni

73yr vs 26 yr male

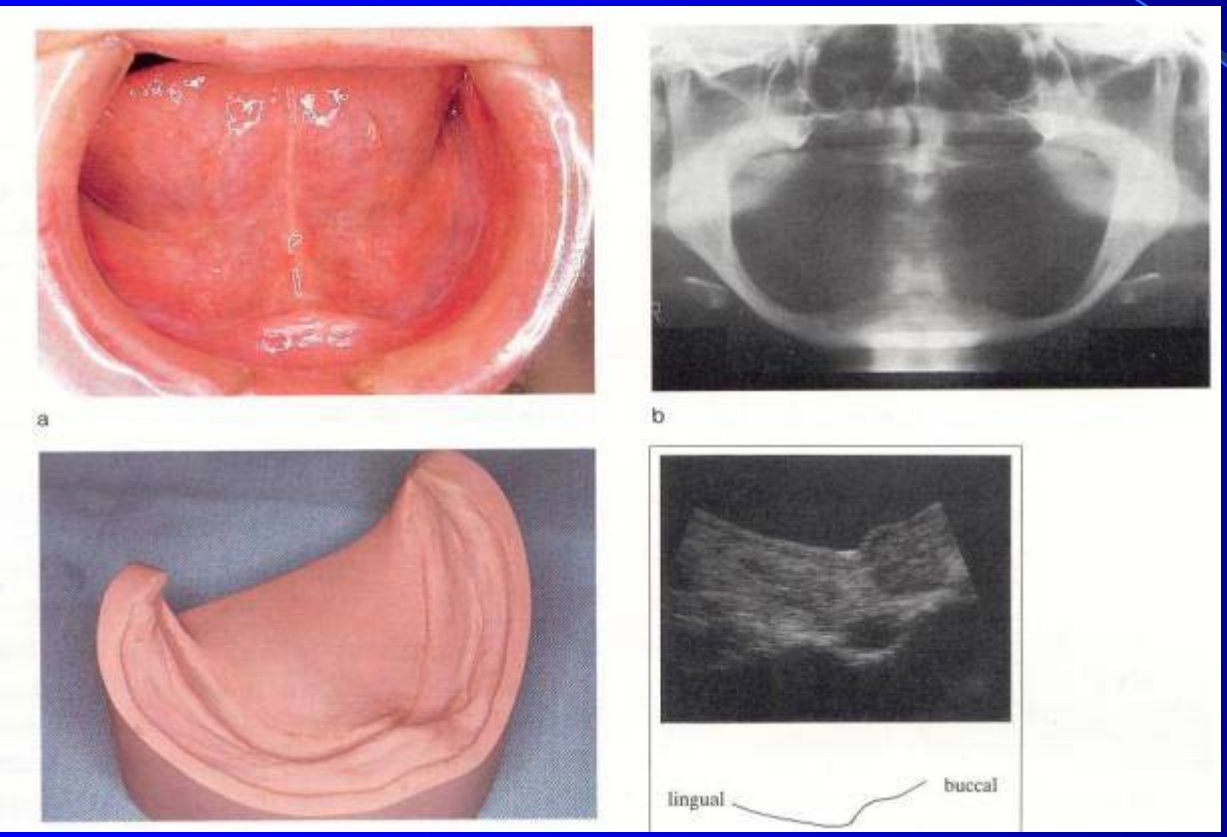
Bone quality and quantity

- Adult peak bone mass is attained by about 35 yr
- Bone mass declines with age -both cortical and trabecular
- Mandibular bone density reduces ~20% between 45 and 90 years, women have lower values
- Bone becomes more brittle, with increasing microfractures of trabeculae
- In elderly, bone turnover is reduced; with osteoclastic >> osteoblastic activity
- Loss of teeth results in loss of alveolar bone – some times very rapidly

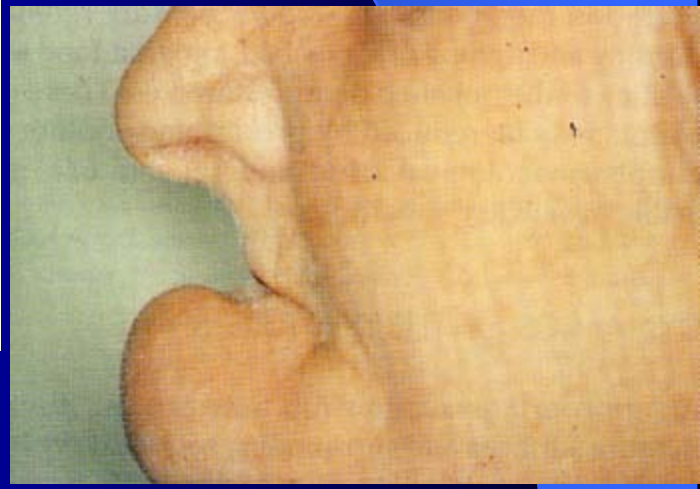
Bone changes following tooth-loss

- Gradual loss of alveolar bone can result in “knife edge alveolar ridges”
- The ascending ramus of the mandible appears longer as the body of the mandible reduces in height

Bone changes following tooth-loss – Clinical appearance

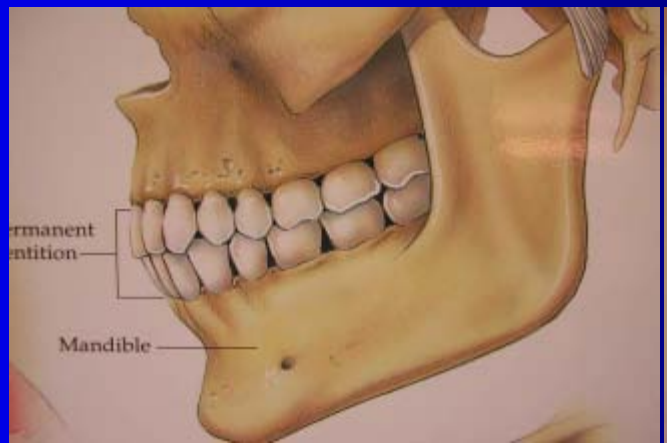


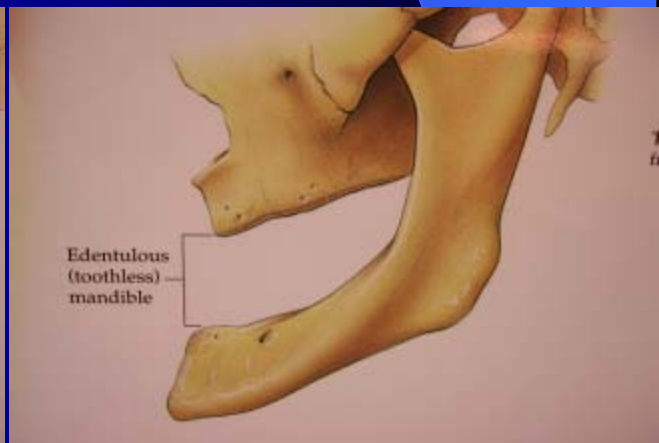
From: Öwall, Käyser & Carlsson. Prosthodontics 1996



Bone changes following tooth-loss

- Gradual loss of alveolar bone results in “knife edge alveolar ridges”
- The ascending ramus of the mandible appears longer as the body of the mandible reduces in height
- The mental foramen relocates superiorly
- Atrophy of bone is more pronounced in the mandible than in the maxilla
- Maxillo-mandibular relationship discrepancy increase





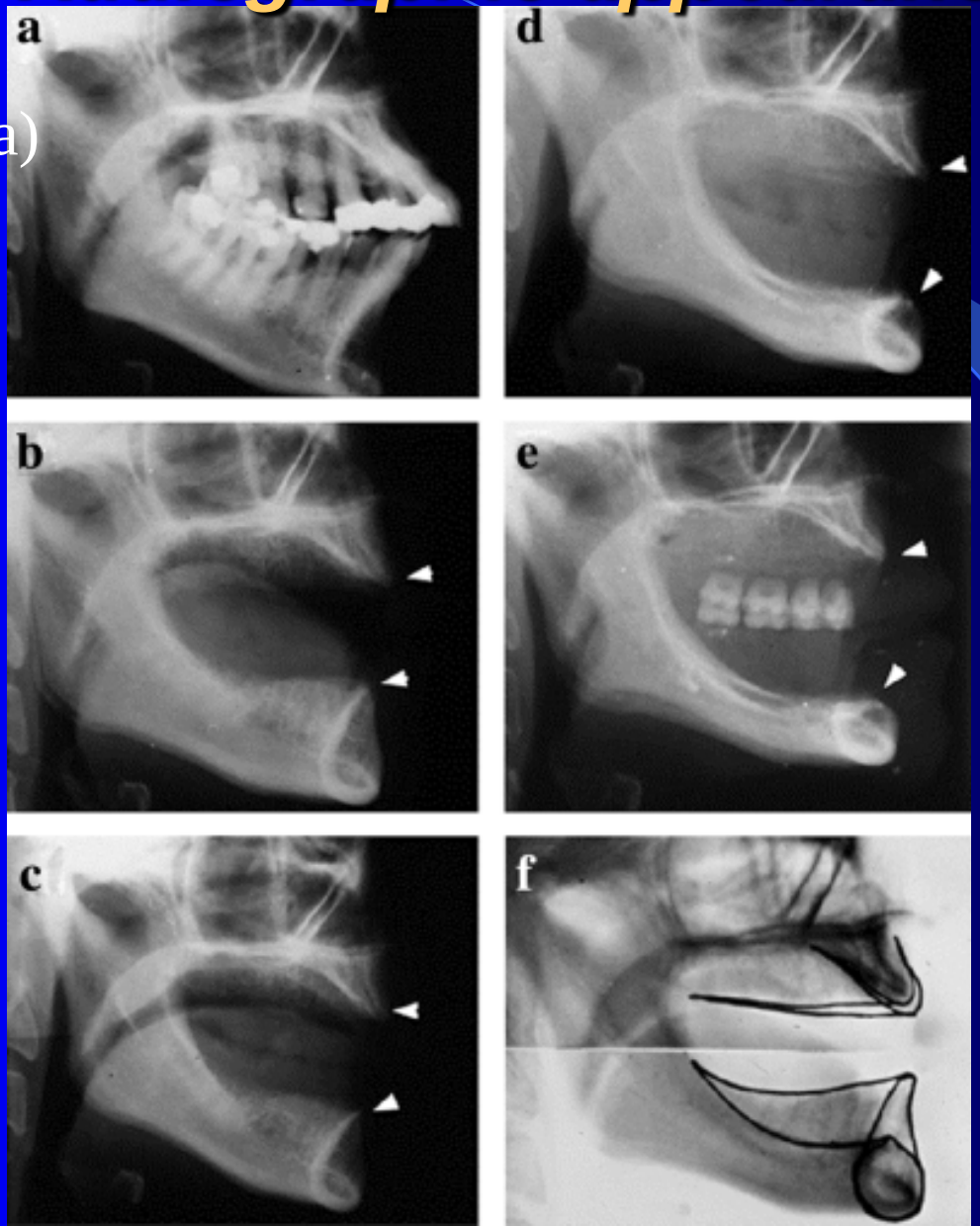
From: Budtz-Jørgensen 1996

Bone changes following tooth-loss – Radiographic appearance

Pre-extraction (a)

3 months post-extraction

7 months post-extraction



17 years postextraction

25 year postextraction

Lost jaw structure

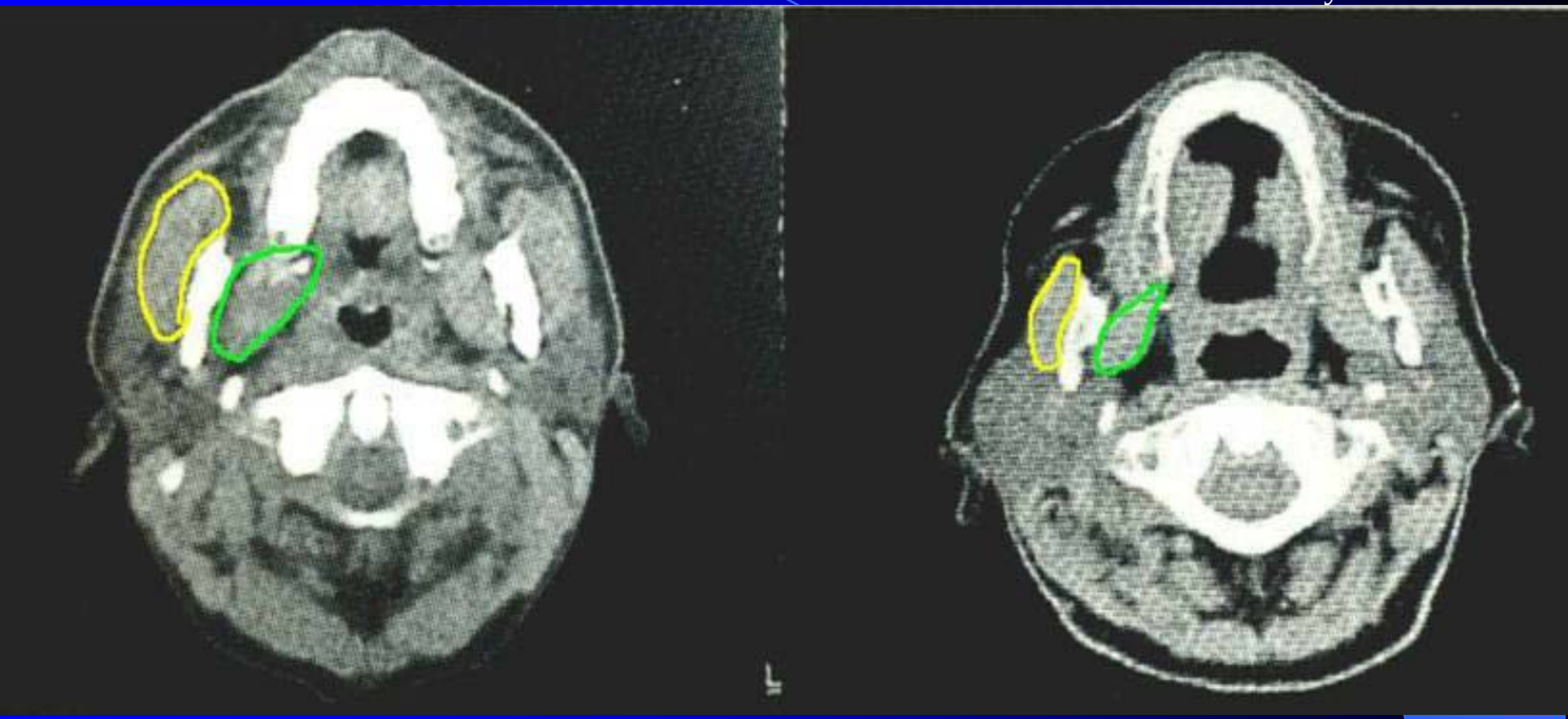
From Nishimura et al. Gerodontology 2004

Neuromuscular changes intraorally

- Characteristic of the ageing process is the loss of muscle mass
- Does not affect the masticatory muscles until relatively late
- Significant reduction in maximum tension and in loss of isometric and dynamic muscle strength in older individuals
- Cross-sectional area of a muscle is an important determinant of maximum force - reducing approximately 40% between 20 and 90 years of age
- Loss of the natural dentition hastens their atrophy

Changes in jaw musculature

Picture: courtesy Dr Kulkarni



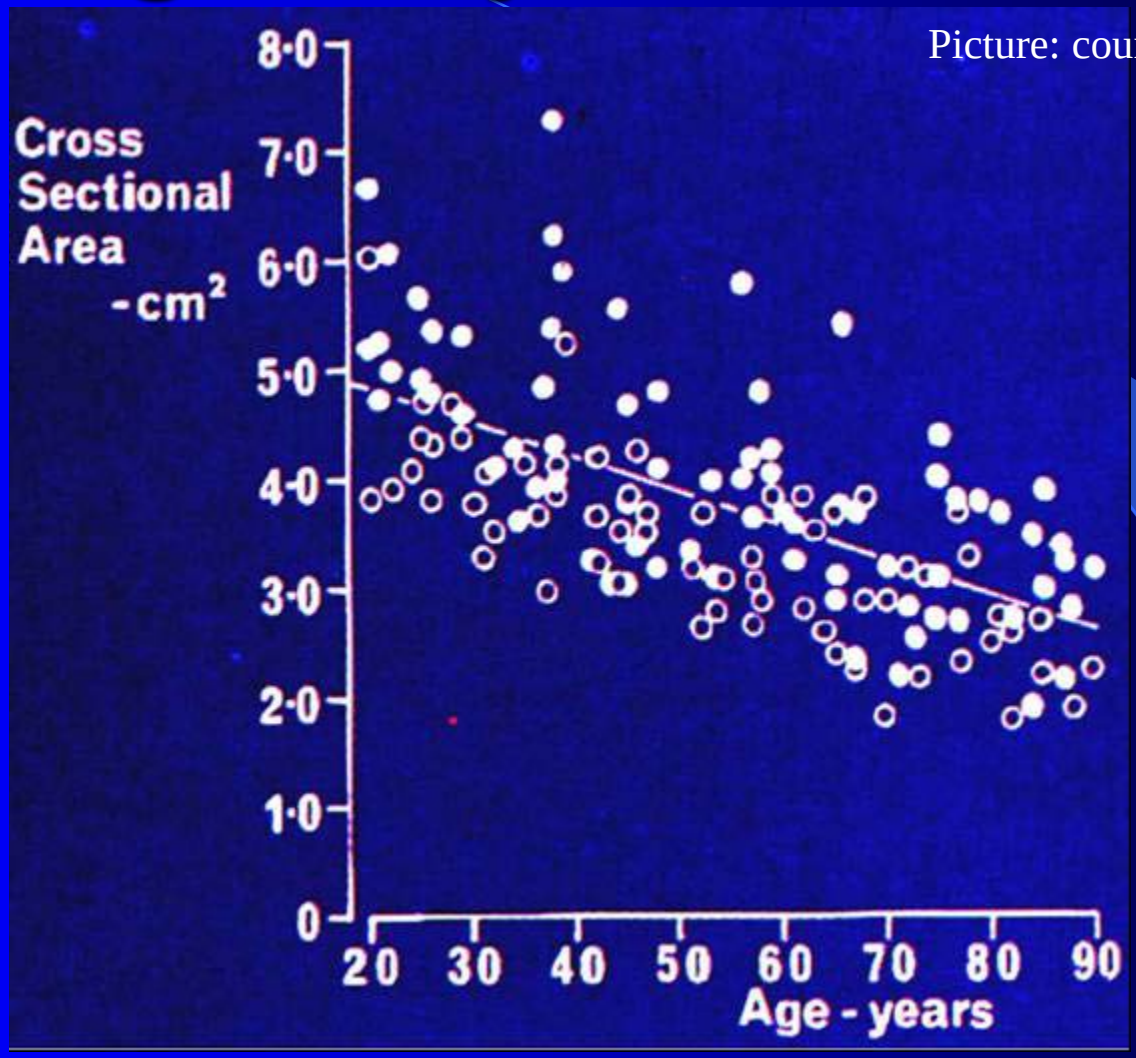
Young individual

Old individual

Computer tomographic (CT) scan of the masseter and medial pterygoid muscles
A substantial reduction in cross- sectional area is seen in the old individual

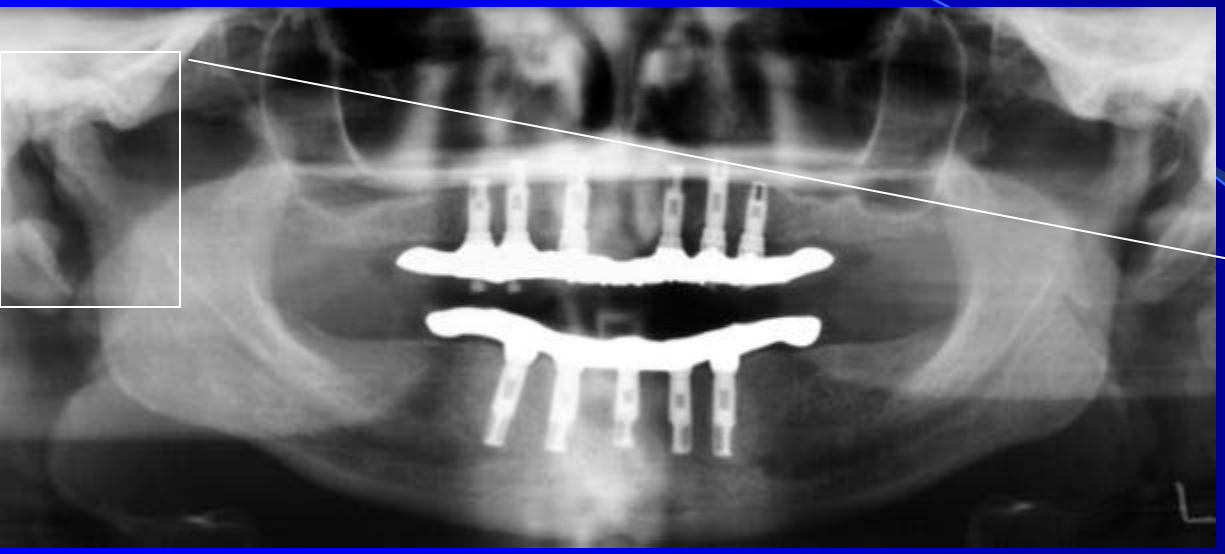
Changes in jaw musculature

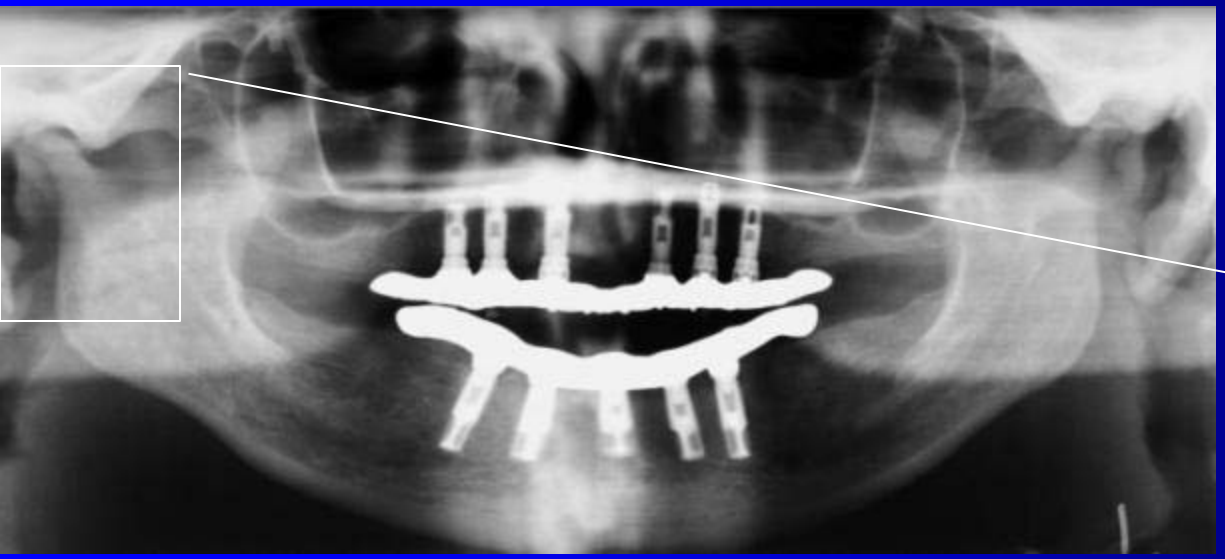
Picture: courtesy Dr Kulkarni



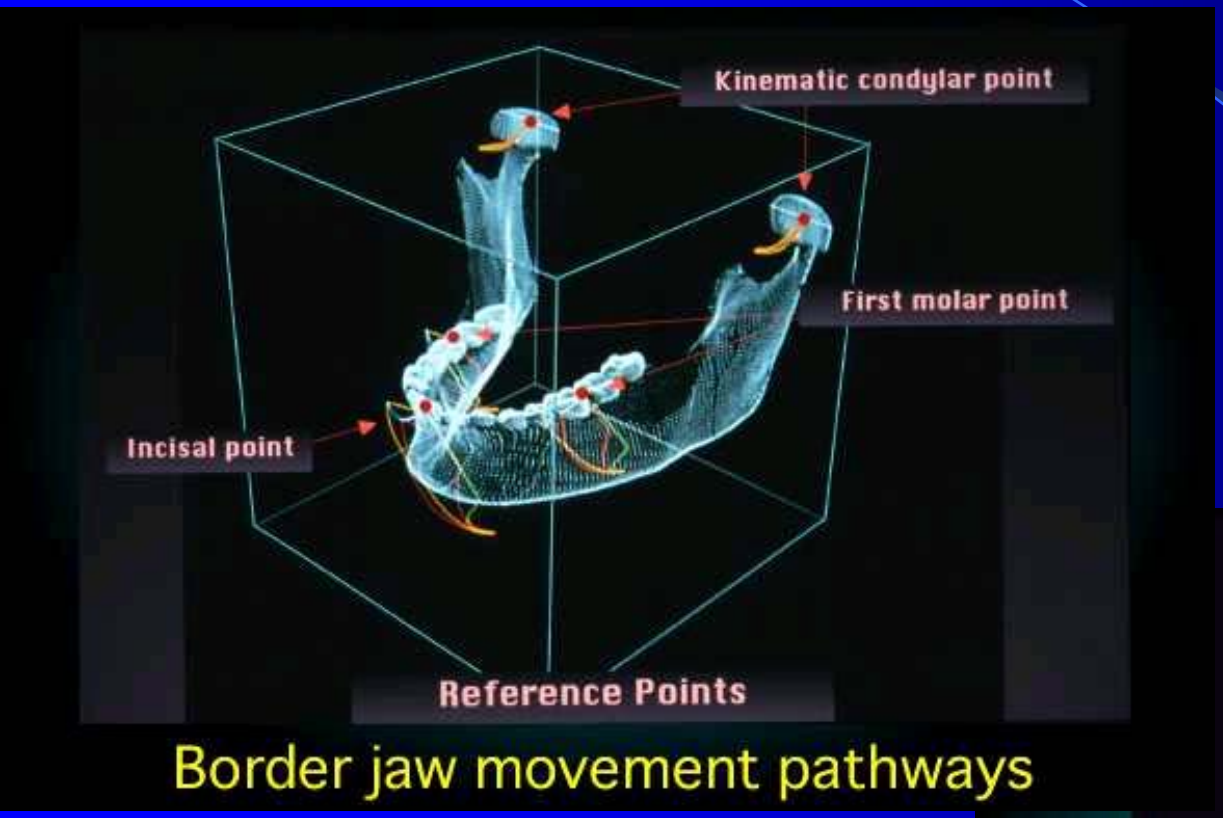
Cross sectional area of the masseter muscle in individuals of different ages: • males, ° females . (N.B. Population and not individual longitudinal data)

Temporomandibular joint - Anatomy

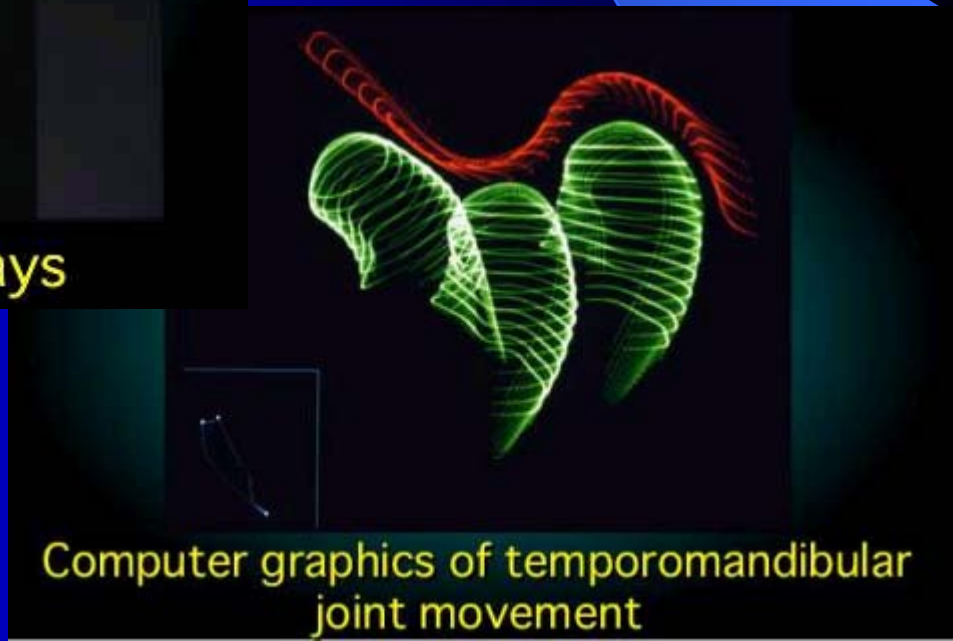




Temporomandibular joint – Normal physiology



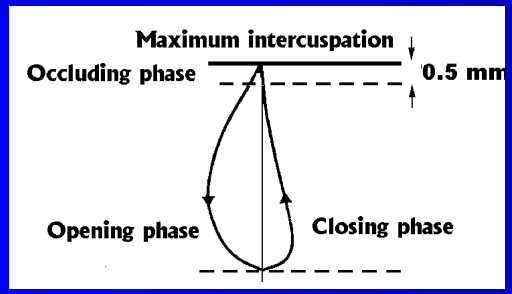
Border jaw movement pathways



Computer graphics of temporomandibular joint movement

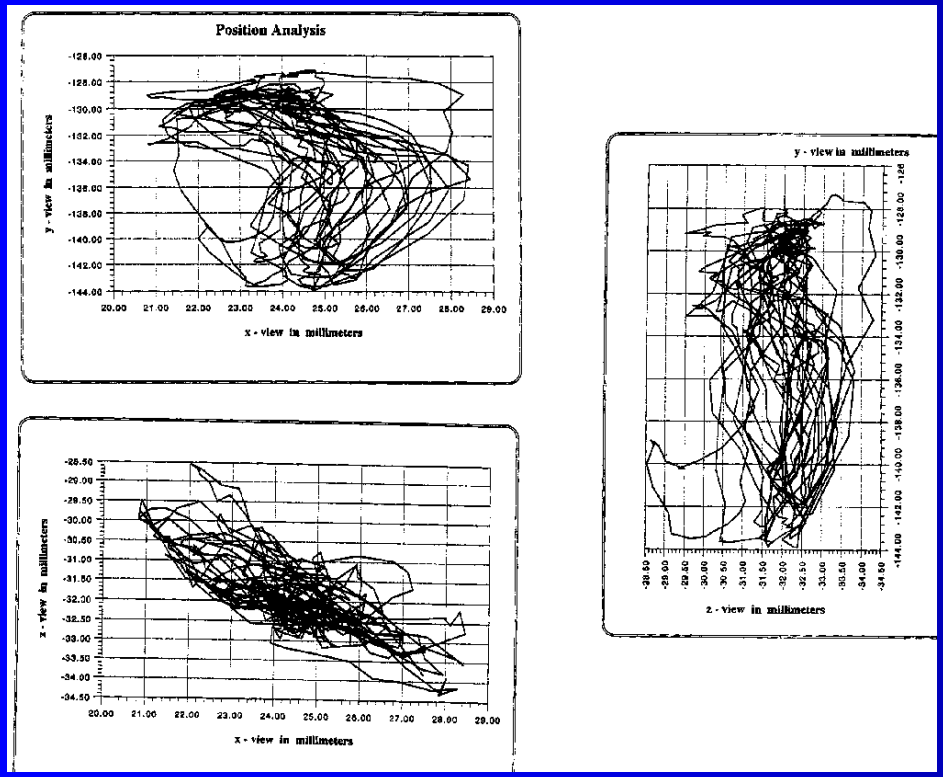
Jaw tracking parametres

Displacement – Frontal / Horizontal / Sagital / Composite

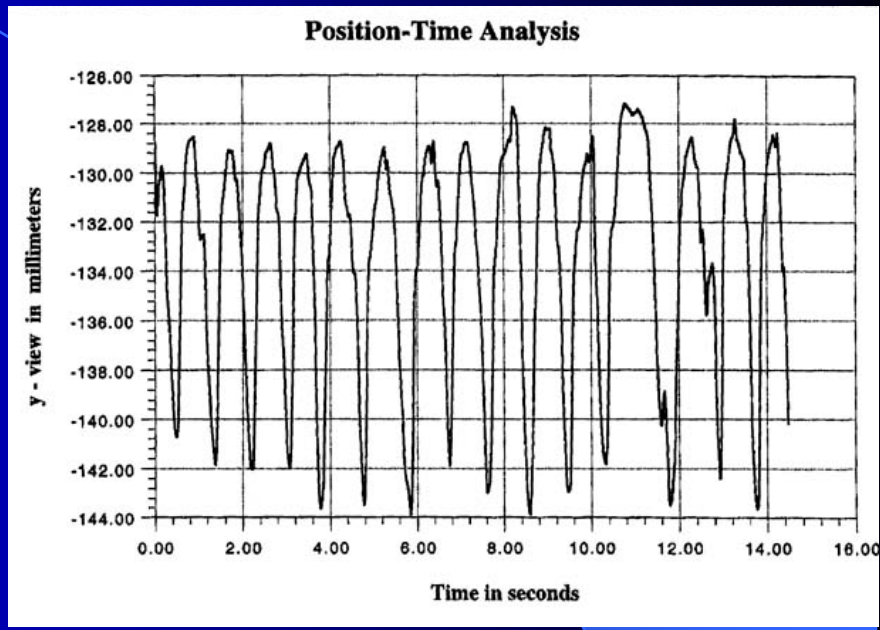


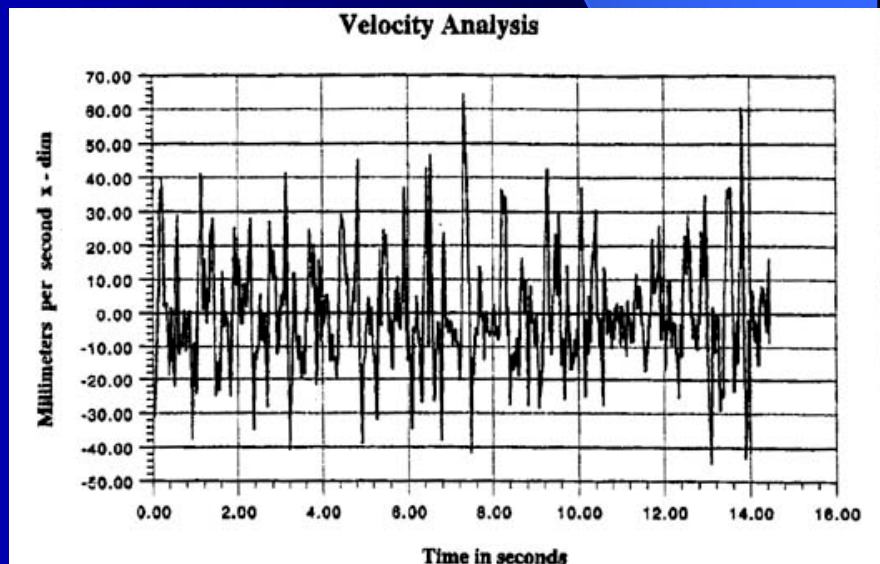
Simplified →

Reality:



Time or Velocity





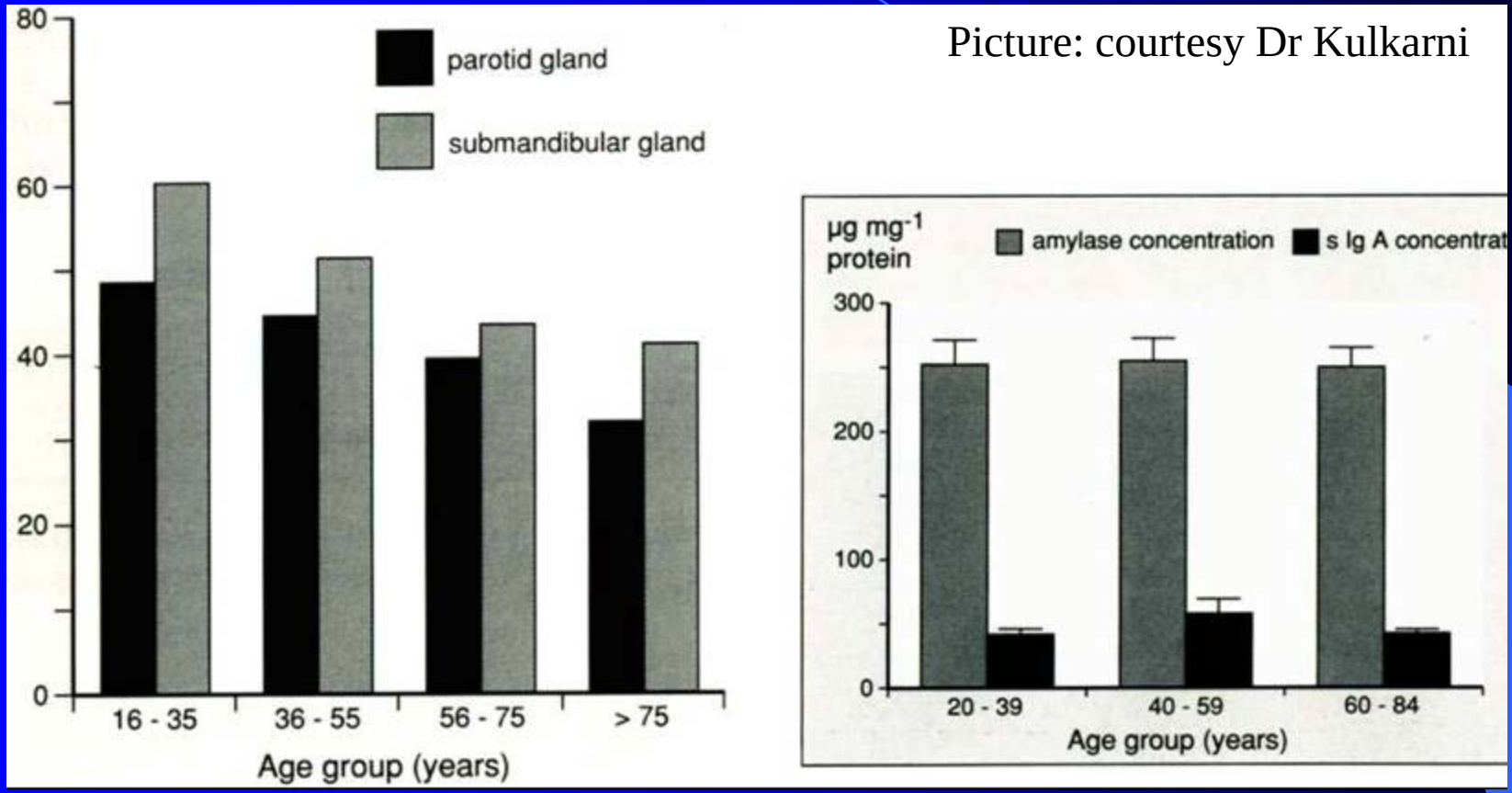
Jaw movements – changes with age

Displacement	No change
Time	Reduced
Displacement/time, i.e. velocity	Reduced
Pattern recognition/classification	No change
Other:	
Rotation	No change
Acceleration	Reduced
Closest speaking space	No change
Postural inter-occlusal space	No change
Chewing preference side	No change
Torque	No change

Salivary glands

- Major and minor salivary glands show a reduction in volume of acinar cells that produce salivary protein
- Slightly greater reduction in submandibular than parotid gland
- If salivary flow rates decline with age, they are modest and may not affect all glands equally
- Protein content also does not reduce significantly
- Salivary glands of older persons are adequately functional but vulnerable to external insults (e.g. anti-depressant drugs, X-radiation)

Saliva quality and quality



Picture: courtesy Dr Kulkarni

Acinar volumes diminish but protein content remains relatively constant

Skin - extraoral

Loss of fat under muscles:

Perioral wrinkles

Disappearance of:

- Lip fullness
- Vermilion border

Deeper

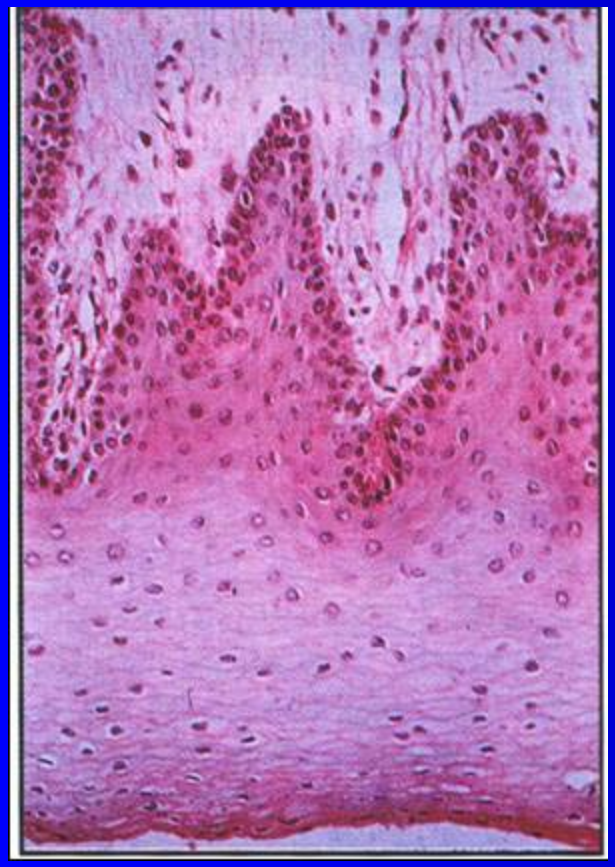
- nasolabial line
- mentolabial line

Prominent

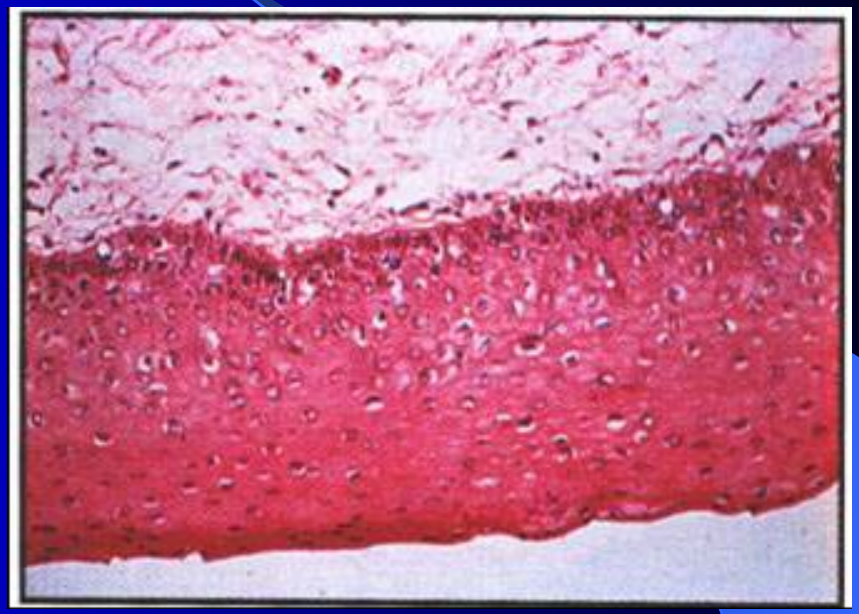
- Nose
- Cheek

"Fillers": Radiesse, Juvederm, Perlane, Restylane...

Mucosa - atrophy



Mucosa from ventral surface of a young tongue.
Note thickness of epithelium and well formed rete ridges

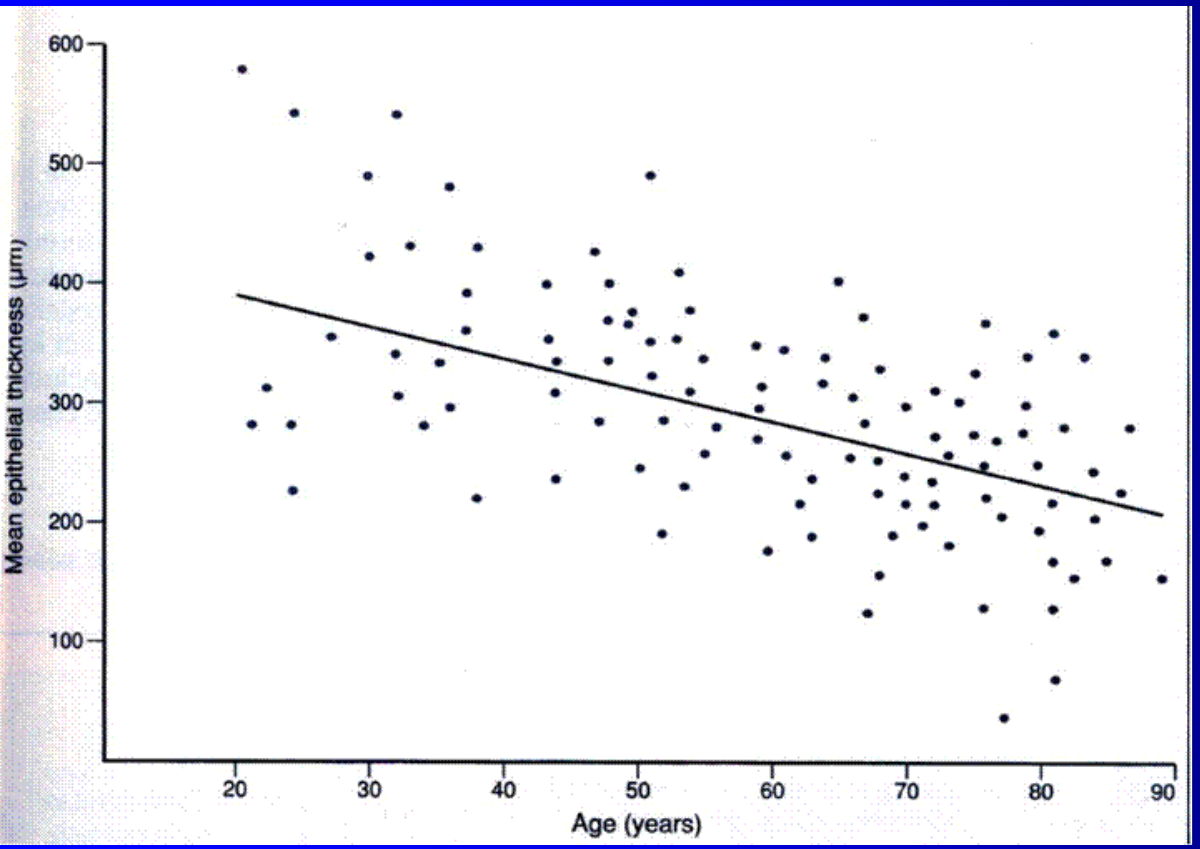


From an old individual
The epithelial layer is reduced in thickness and the rete ridge system is lacking.
Such mucosa may be susceptible to trauma

Pictures: courtesy Dr Kulkarni

Intraoral mucosa

- Epithelium becomes thinner and poorly differentiated
- Mucosa undergoes atrophy with age



Reduction of mean epithelial thickness of the lingual border of the human tongue with age

Thin mucosa can be extremely sensitive under a denture. Many patient never uses their lower denture

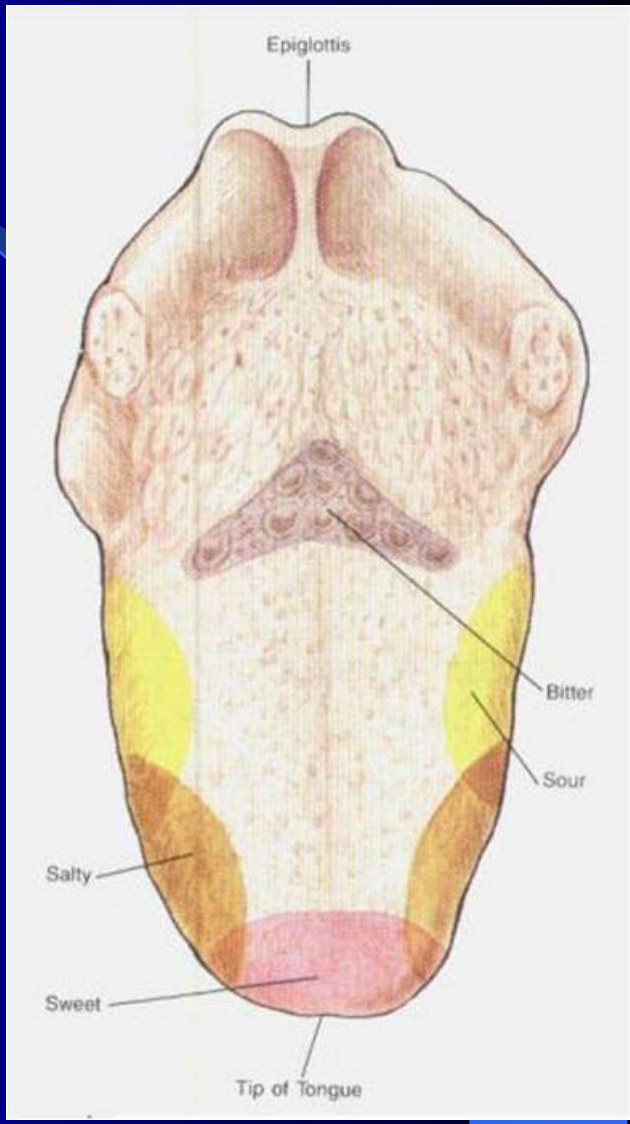
Pictures: courtesy Dr Kulkarni

Mucosa – connective tissues

- There is an increase in collagen content in the underlying connective tissue
- Keratinization of the palate and gingivae is reduced and conversely the cheeks and lips tend towards keratinization
- Mucosa undergoes atrophy with age
- Collagen fibre thickness increases with age in skin and mucosa
- The collagen thickness increase does not appear to happen in the pulp

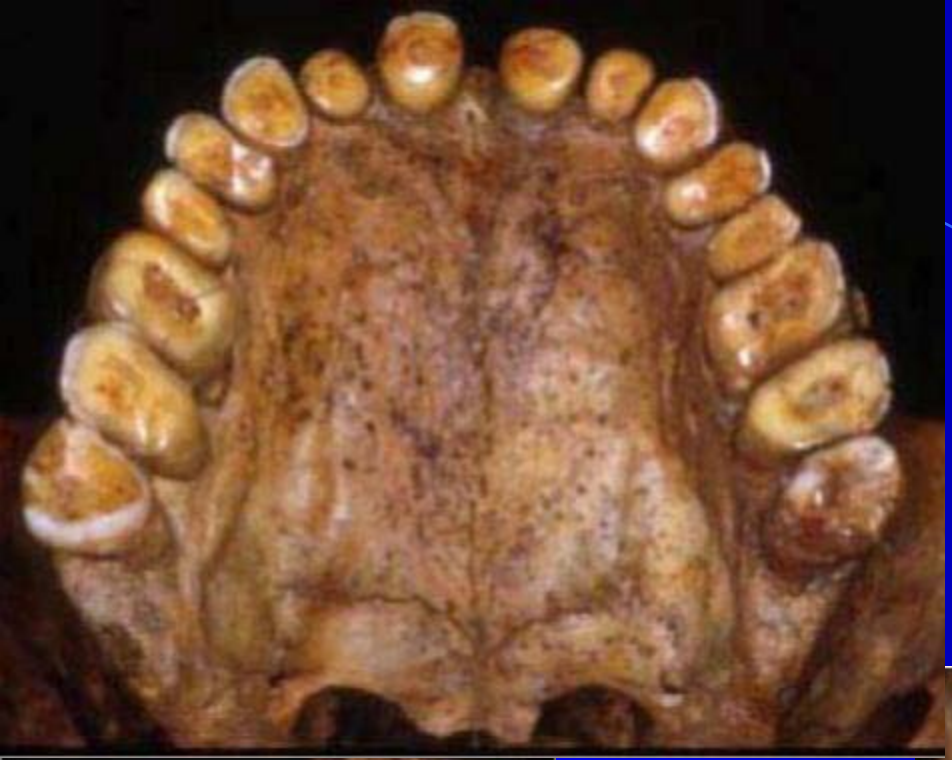
Changes in taste

- Overall ability to taste diminishes
- Changes also occur in various modalities of taste
- Habitual intake of drugs, nicotine and alcohol changes/diminishes taste perception
- Cirvumvallate papillae on which some of the taste buds are located atrophy thereby reducing number of taste buds
- Gradual loss of fungiform papillae also occurs

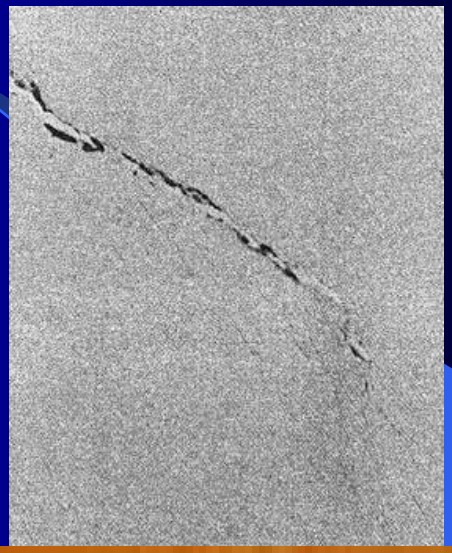


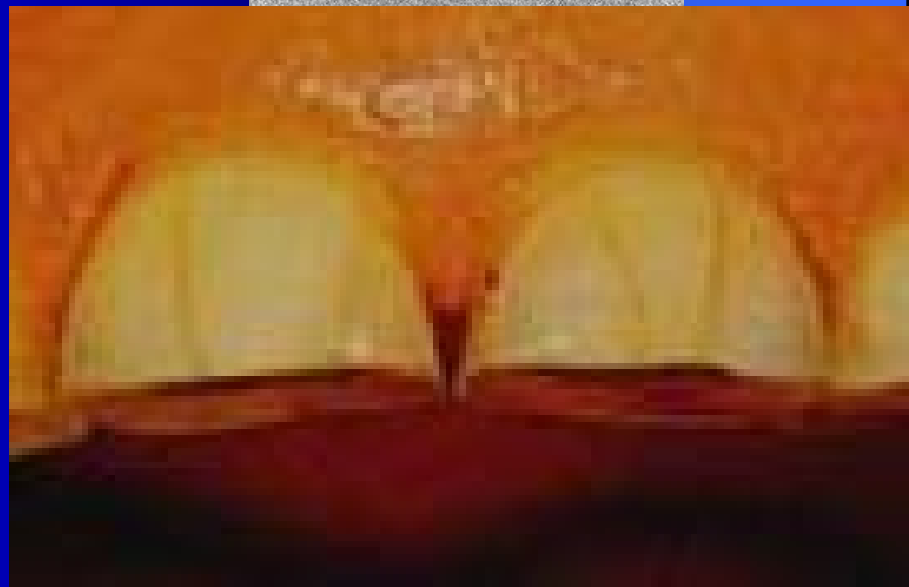
Dentition – stone age

Dentition – 17th century



Dentition – 21th century





Gingival recession

Enamel wear and cracks

Exposed dentin

- *attrition, abrasion*

Dentition – tribological mechanisms

- **Attrition** develops due to friction
- Loss of face height may or may not follow attrition. Sometimes compensatory deposition of cementum and/or bone maintain face height
- Interocclusal clearance (freeway space) remains constant through age by continuous eruption
- **Corrosion** (AKA "erosion") can occur through presence of acids in foods and beverages
- A**brasio**n occurs especially in cervical regions
- Irreversible tooth loss – accumulation over years

Aged dentitions – 21th century

Grippo et al. JADA 2004 135; 1109

STRESS
[Microfracture/ Abfraction]
Endogenous
Exogenous

FRICTION
[Wear]
Endogenous (Attrition)
Exogenous (Abrasion)

CORROSION
[Chemical Degradation]
Endogenous
Exogenous

Grippo et al. JADA 2004 135; 1109

STRESS
[Microfracture/ Abfraction]
Endogenous
Exogenous

FRICTION
[Wear]
Endogenous (Attrition)
Exogenous (Abrasion)

CORROSION
[Chemical Degradation]
Endogenous
Exogenous

Endogenous
Parafunction
Occlusion
Deglutition

Exogenous
Mastication
Habits
Occupational behaviors
Use of Dental appliance

Endogenous
Parafunction
Deglutition

Exogenous
Mastication
Dental Hygiene
Habits
Occupational behaviors
Use of Dental appliance

Endogenous: Plaque – gingival crevicular fluid – Gastric juice
Exogenous: Diet -Occupational exposures - Certain drugs/alcolhol

Grippo et al. JADA 2004 135; 1109

Saliva stimulation factor?

STRESS
[Microfracture/ Abfraction]
Endogenous
Exogenous

FRICTION
[Wear]
Endogenous (Attrition)
Exogenous (Abrasion)

CORROSION
[Chemical Degradation]
Endogenous
Exogenous

Endogenous
Parafunction
Occlusion
Deglutition

Exogenous
Mastication
Habits
Occupational behaviors
Use of Dental appliance

Endogenous
Parafunction
Deglutition

Exogenous
Mastication
Dental Hygiene
Habits
Occupational behaviors
Use of Dental appliance

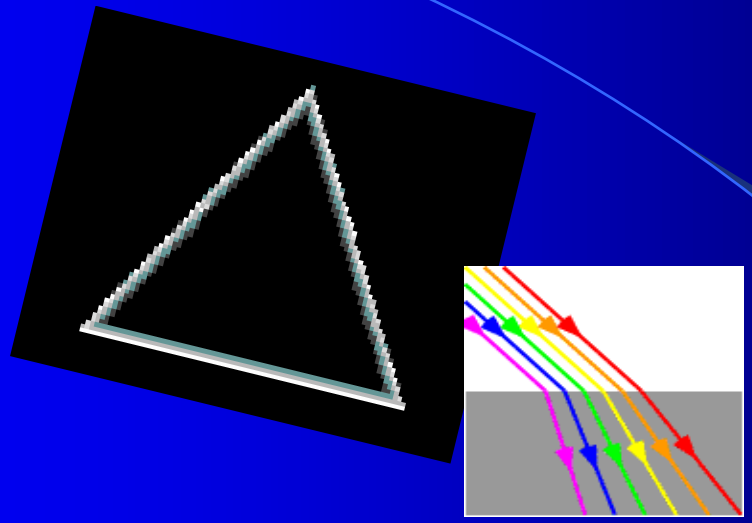
Endogenous: Plaque – gingival crevicular fluid – Gastric juice

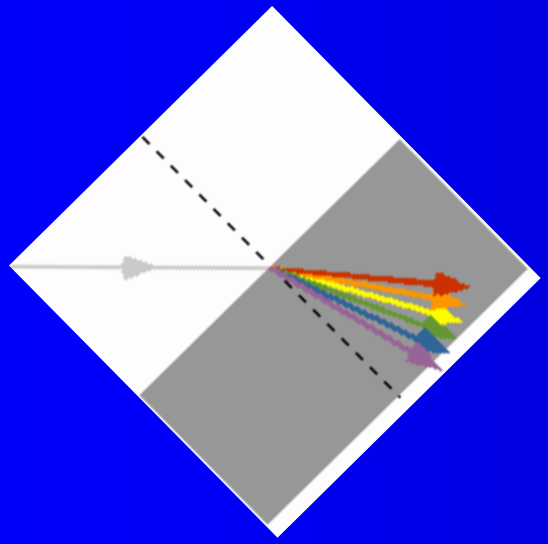
Exogenous: Diet -Occupational exposures - Certain drugs/alcolhol

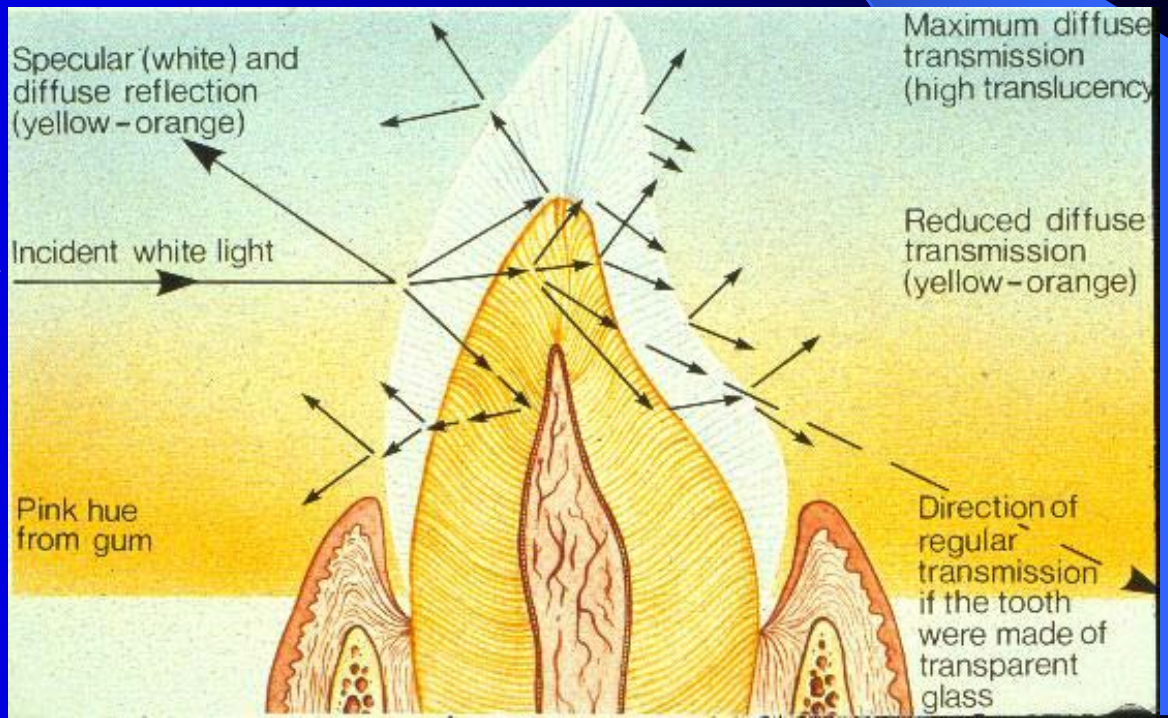
Vertical Dimension of occlusion and Continuous Tooth Eruption

- Tooth eruption continues throughout life.
- Passive eruption - exposure of teeth by apical migration of gingiva, i.e., caused by gingival recession or atrophy
- Recession is not a normal physiologic process of aging.
- Active eruption - movement in vertical plane.
- Apposition of bone accompanies active eruption. Gingiva may or may not follow the crown
- Exposed roots can be sensitive and risk for caries cementum >> enamel
- Distance between apical portion of junctional epithelium and alveolar bone remains constant in the absence of disease

Dentition – shade and color





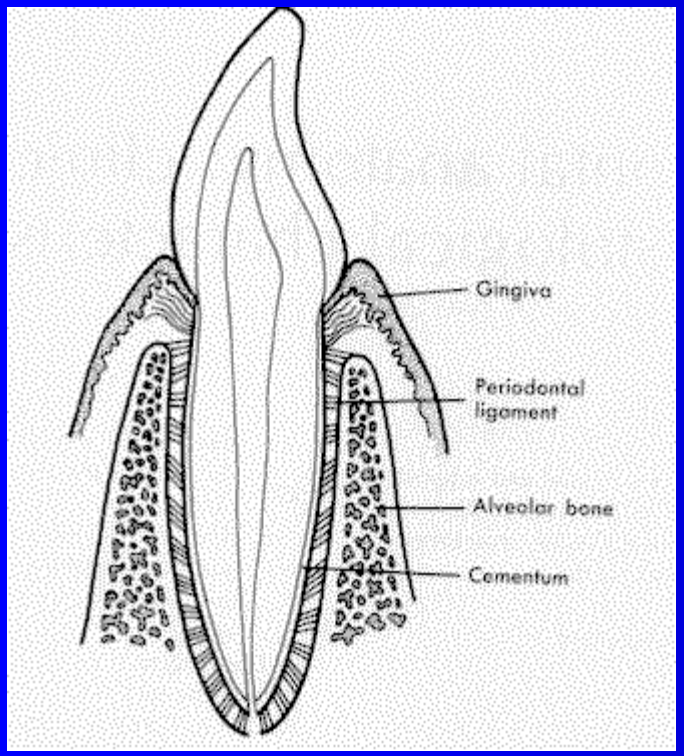


From: McLean 1980

Dentition – shade and color

- Enamel appears to darken with age due to secondary dentin formation, and accumulation of stains
- Enamel (and dentin) become less permeable with age
- Changes in enamel and dentin, such as desiccation cause teeth to become brittle with age – this can lead to cracks which is of consequence in tooth preparation and during extractions

Periodontium



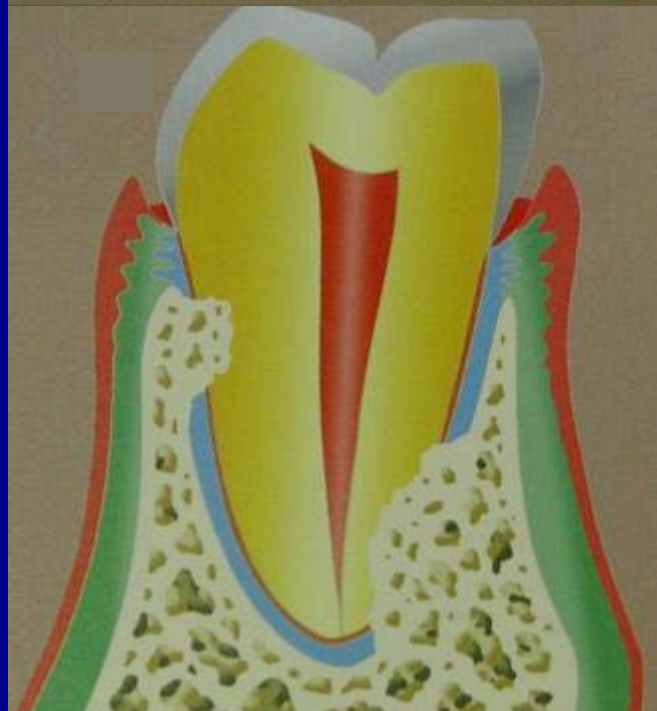
Functions:

- **Viscoelastic cushion**
- **Sensory organ**
- **Accommodates tooth movements**
- **Regulates osteogenesis**

Not uncommon observations in elderly

Surface Resorption

Inflammatory Resorption
-granulation tissue



Replacement Resorption
→ ankylosis

Periodontium

- In a clean mouth, narrowing of periodontal ligament space, attrition and firm teeth can occur
- Cementum deposition in response to wear and trauma occurs – this can aid in forensic cases for the purposes of age determination
- Gingival recession is not universal and depends primarily on hygiene.

Pulp - neurovascular

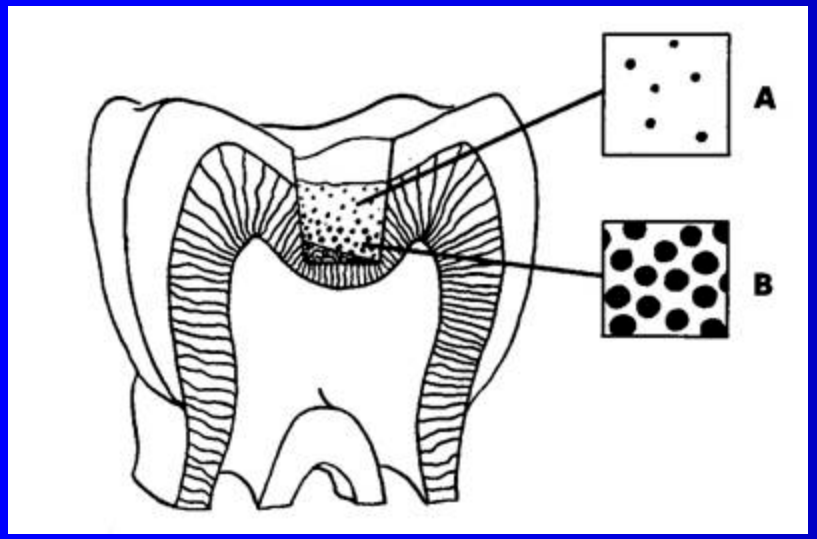
- Histologically pulp becomes more fibrotic as cellular and nervous content decreases
- Teeth become less sensitive to instrumentation and vitality testing
- Rapid loss of enamel and dentin on the other hand can lead to increase in sensitivity to temperature and touch if the tooth does not have sufficient time to respond with reparative dentin

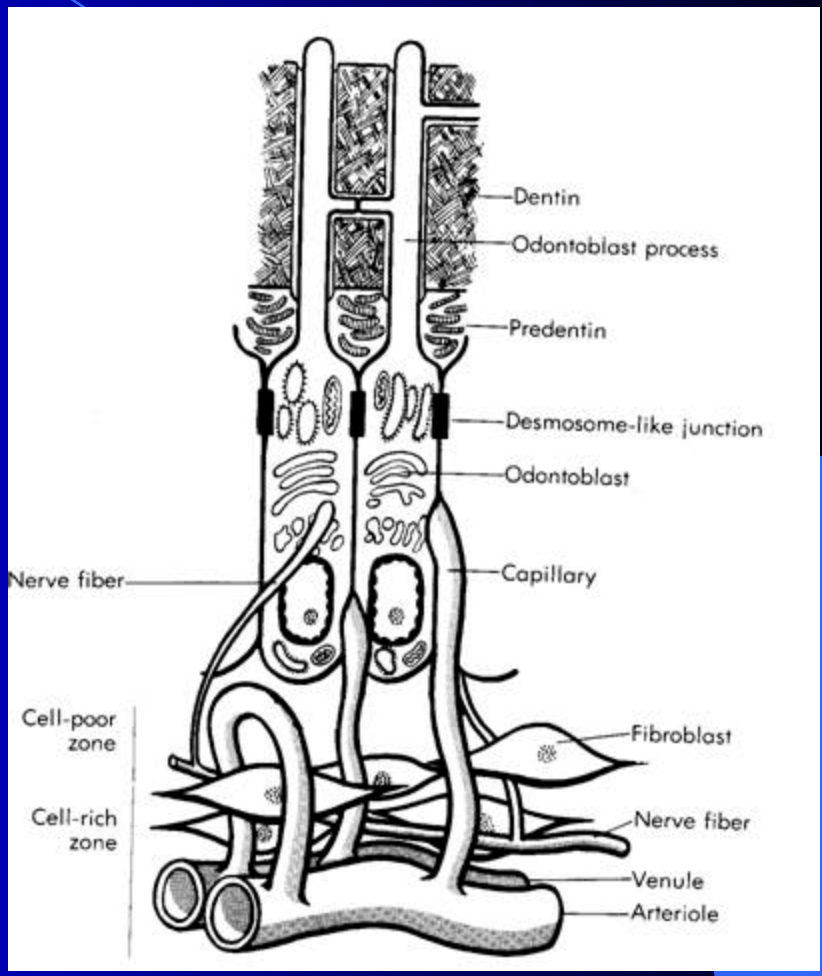
Endodontium

Consists of two components :

Dentin

Pulp

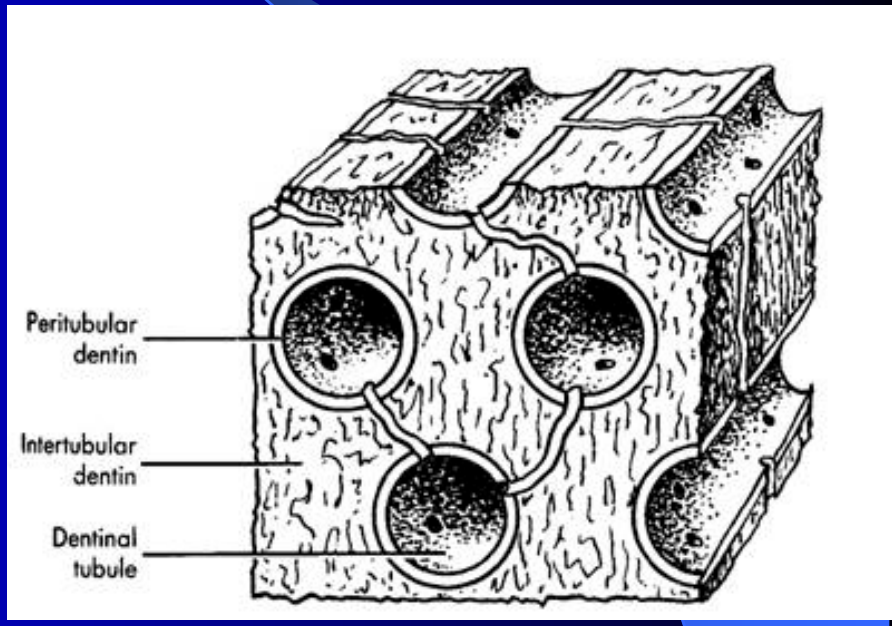




(From Tronstad, 1988)

Endodontium - Dentin

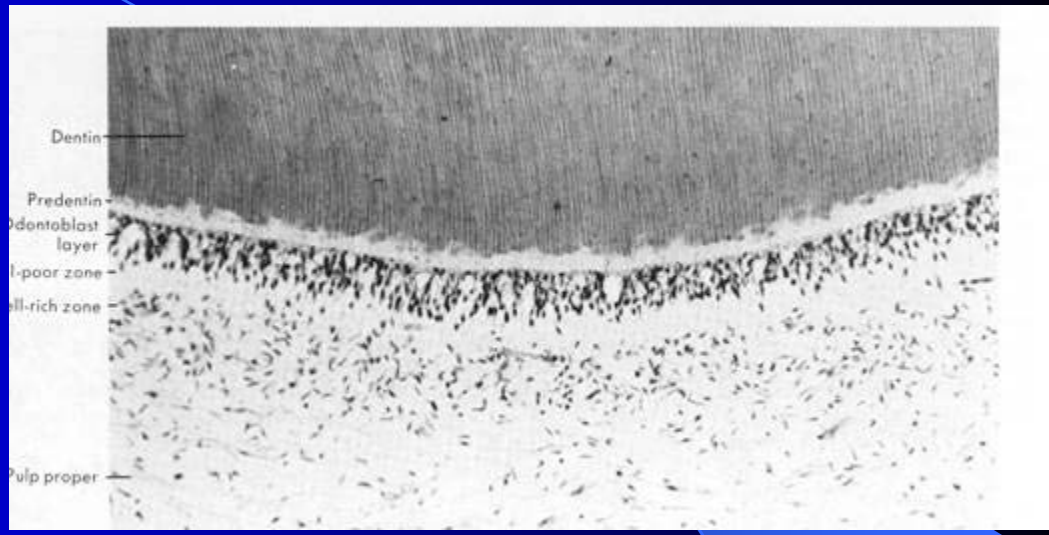
- *Dentin tubuli*
  - *Fluid*
  - *Collagen +/- mineralized*
  - *Non-myelinated nerveends*
  - *Odontoblasts*
- *Peritubular dentin*
- *Intertubular dentin*

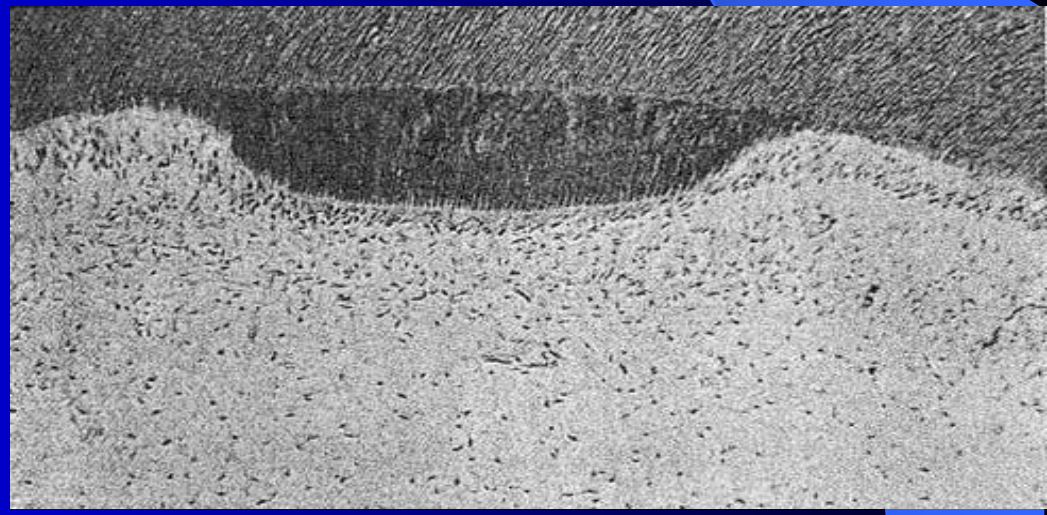


(From Tronstad, 1988)

Endodontium – Pulp

- *Odontoblasts*
- *Preodontoblasts*
- *Mesenchymal cells, fibroblasts, fibrocytes, collagen, lymfocyttes, makrofages , plasmacells*
- *Ground substance*





Occlusion of tubuli – sclerotizing of dentin

Peritubular dentin

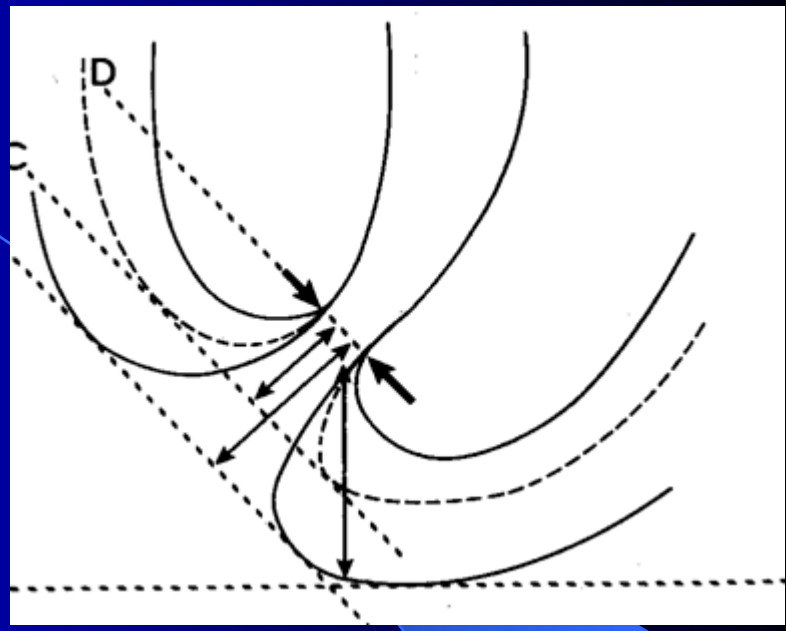
Intratubular dentin

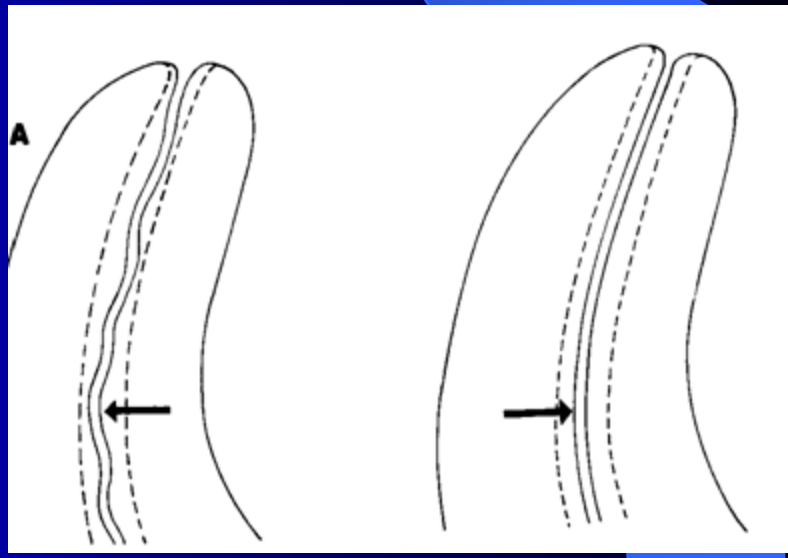
"Occusion" of pulp

- *Secondary dentin*
- *Reparative dentin*

(From Mjor & Tronstad, 1974)

- Odontoblast cell layer becomes partially or completely damaged
- Secondary dentin and intrapulp stones obliterate large parts of the pulp
- Intact blood vessels and soft tissues can be embedded in the secondary dentin
- Much collagen fibres and fewer cells
- Few prominent blood vessels
- Root canals become more or less obliterated by the secondary dentin





(From Tronstad, 1988)

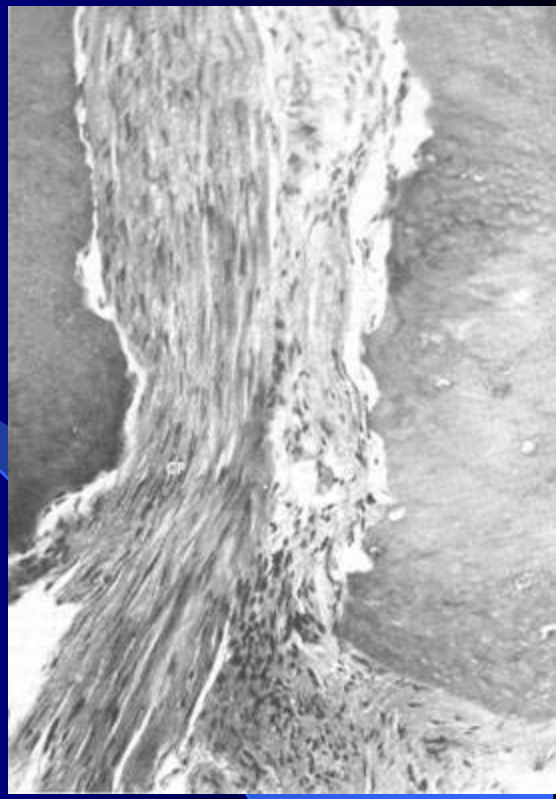
Endodontium

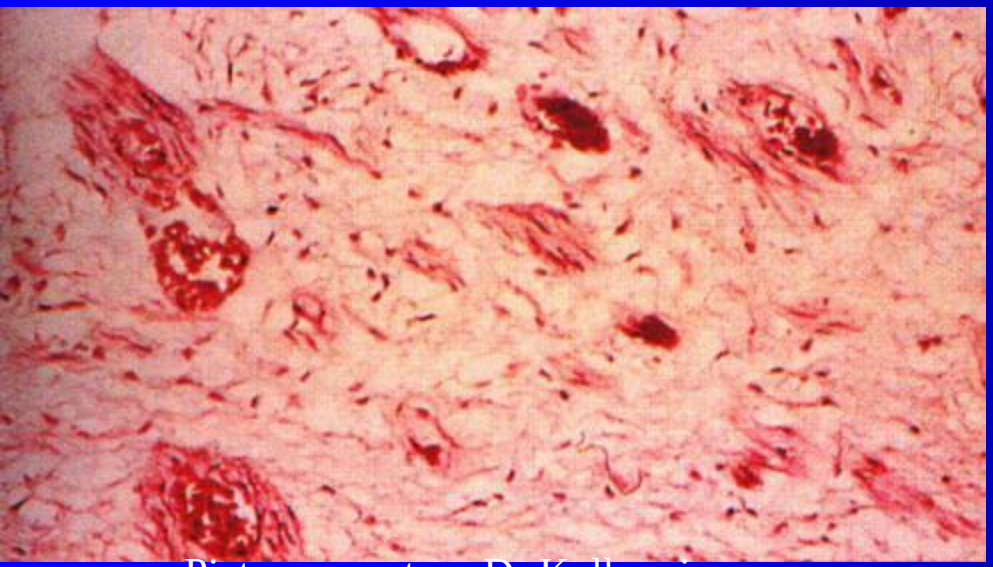
Fibre amount

Blood supply

Nerve tissue

Pulp- stones /calcification





Picture: courtesy Dr Kulkarni

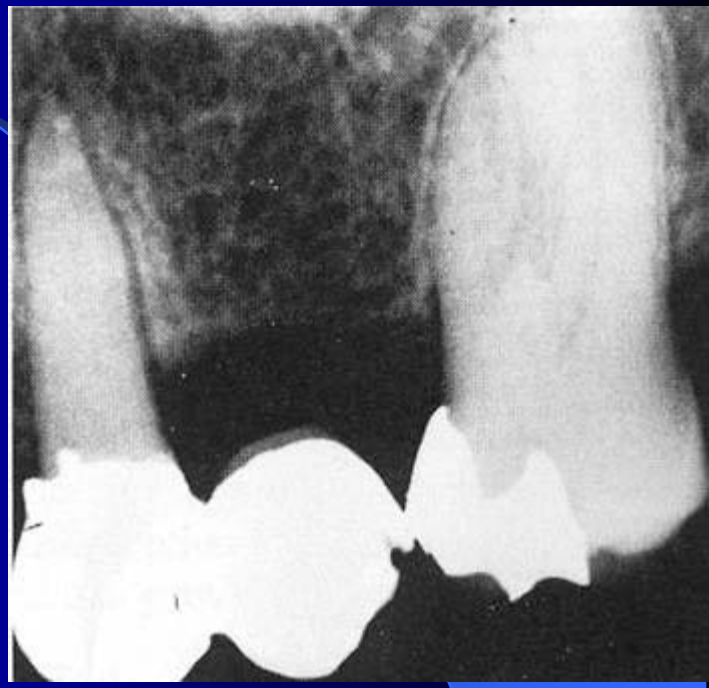
Endodontium – physiology aspects

Radiographical changes

- *Crown pulp obliteration*
- *Root pulp obliteration*
- *Radiographic apex foramen distance.*

Pain diagnostics

- *Vitality testing*
- *Accelerated necrosis*
- *Chronic pain not uncommon*



Ground section through a root showing marked secondary/reactionary dentin deposition (A), which can be distinguished from primary dentin (B)

Picture: courtesy Dr Kulkarni

The mouth mirrors (a long) life

Oslo Vigeland Park. Gustav Vigeland 1869-1943

The mouth as a mirror of life:

Manifestations:
Systemic conditions

- Angle of the mouth lesions - “Cheilitis”
- The dorsal surface of the tongue shows a tendency to become smoother with atrophy of the papillae and may develop fissuring
- The appearance of the tongue and the lesions at the corner of the mouth can be secondary to vitamin deficiencies

The mouth as a mirror of life:

Manifestations of:
Systemic conditions
Drug side-effects

Top drug classes by rate of use and age *

Drug class	Common uses	Rates 65-74	75-84	85+
Statins	High cholesterol	39.7	39.7	24.3
Ace inhibitors	Hypertension, heart failure	27.0	31.6	31.7
Proton pump Inhibitors	Gastro-intestinal reflux	20.9	24.1	25.7
Beta-blockers	Hypertension, angina	20.7	26.8	27.9
Thyroid hormones	Hypothyroidism	16.4	20.4	24.3
Calcium channel blockers	Hypertension	16.1	21.9	24.2
Opioids	Pain	15.2	15.3	–
Thiazide diuretics	Hypertension	14.6	16.9	16.5
Angiotensin receptor blockers (ARBs)	Hypertension	13.8	16.0	–
Sulfonamide diuretics	Hypertension, heart failure	–	14.9	27.6
Fluoroquinolones	Infections	–	–	16.0
Biguandies	Diabetes	14.0	–	–

* Based on prescription drug claims data from six provinces: Alberta, Saskatchewan, Manitoba, New Brunswick, Nova Scotia, PEI

TRISH McALASTER / THE GLOBE AND MAIL » SOURCE: CANADIAN INSTITUTE FOR HEALTH INFORMATION

The Globe and Mail, Friday, March 19, 2010

CANADIAN INSTITUTE FOR HEALTH INFORMATION » MULTIPLE MEDICATIONS

Study warns about seniors' prescriptions

Two-thirds of retirement-age Canadians are taking five or more prescription medications

The mouth as a mirror of life:

Manifestations of:

Systemic conditions

Drug side-effects

Nutrition

Tribological factors

(**Repetitive over years**)

The mouth as a mirror of life:

Manifestations of:

Systemic conditions

Drug side-effects

Nutrition

Tribological factors

Iatrogenic factors

Tissue removal in the past caused by inadequate biomaterial properties

Restoration margins leakage

Nothing lasts forever!

Minimal Intervention principle for choice of biomaterials, devices and procedures

Patient age: 92 yrs– FDPs 40+yrs

Patient age: 87yrs FDP 40+yrs

The mouth as a mirror of life:

Manifestations of:

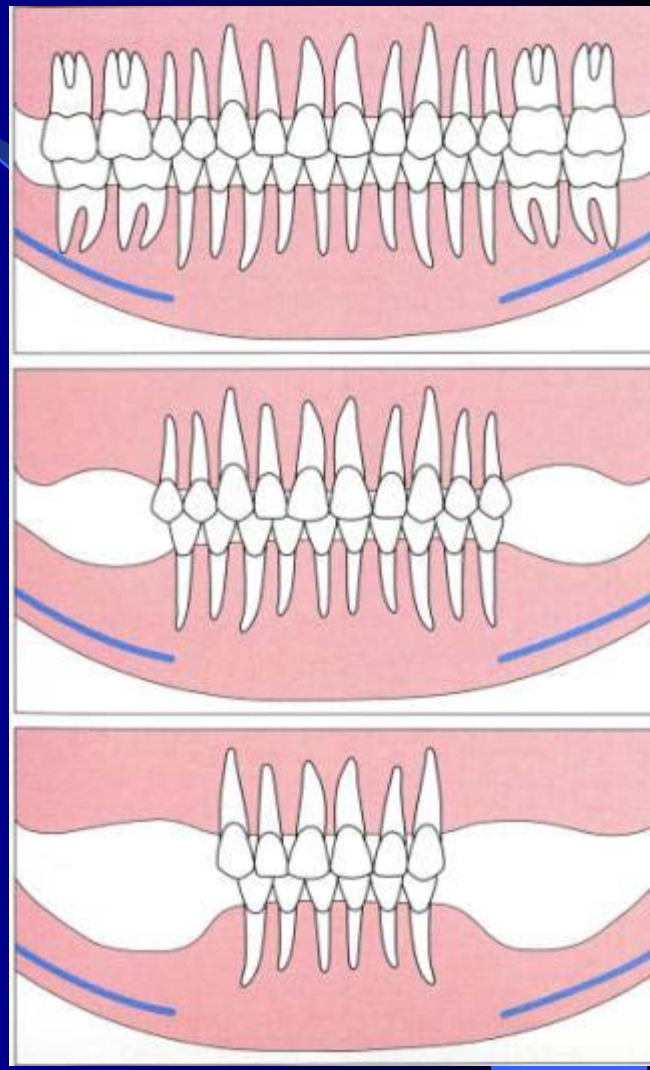
Systemic conditions

Drug side-effects

Nutrition

Tribological factors

Iatrogenic factors



SDA- Shortened Dental arch concept

The mouth as a mirror of life:

Manifestations of:

Systemic conditions

Drug side-effects

Nutrition

Tribological factors

Iatrogenic factors

Smoking &

Biofilms are the major causes for oral diseases!