The essential conditions of success of the implantation III.

The factors influencing the masticatory load transmission through implants

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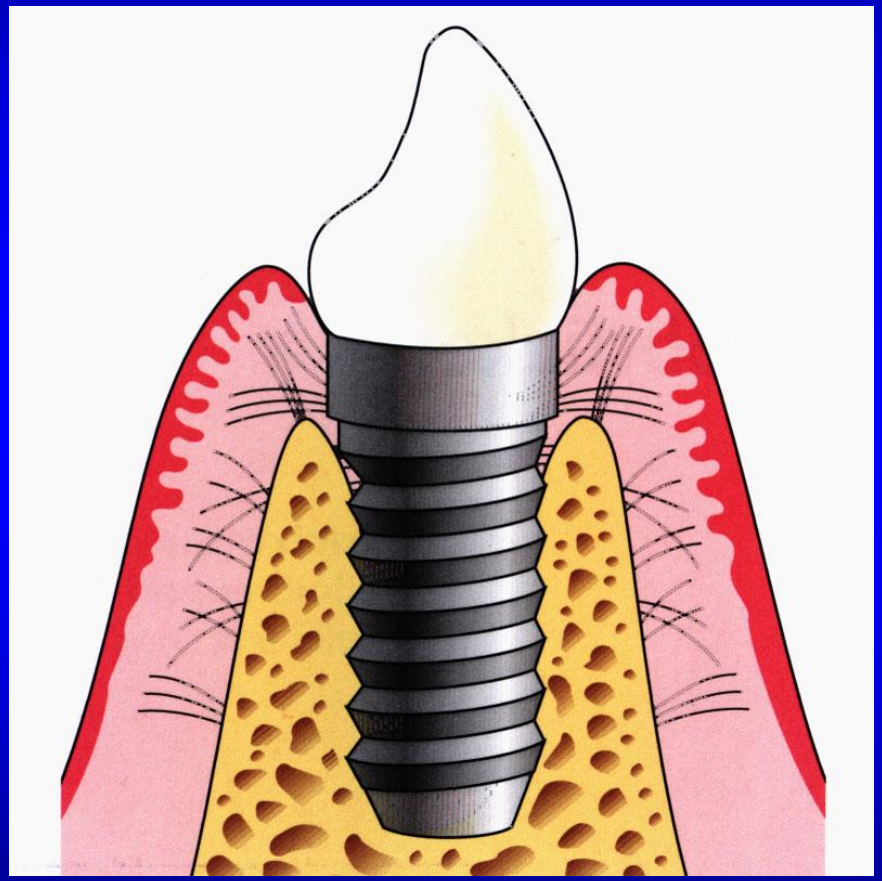
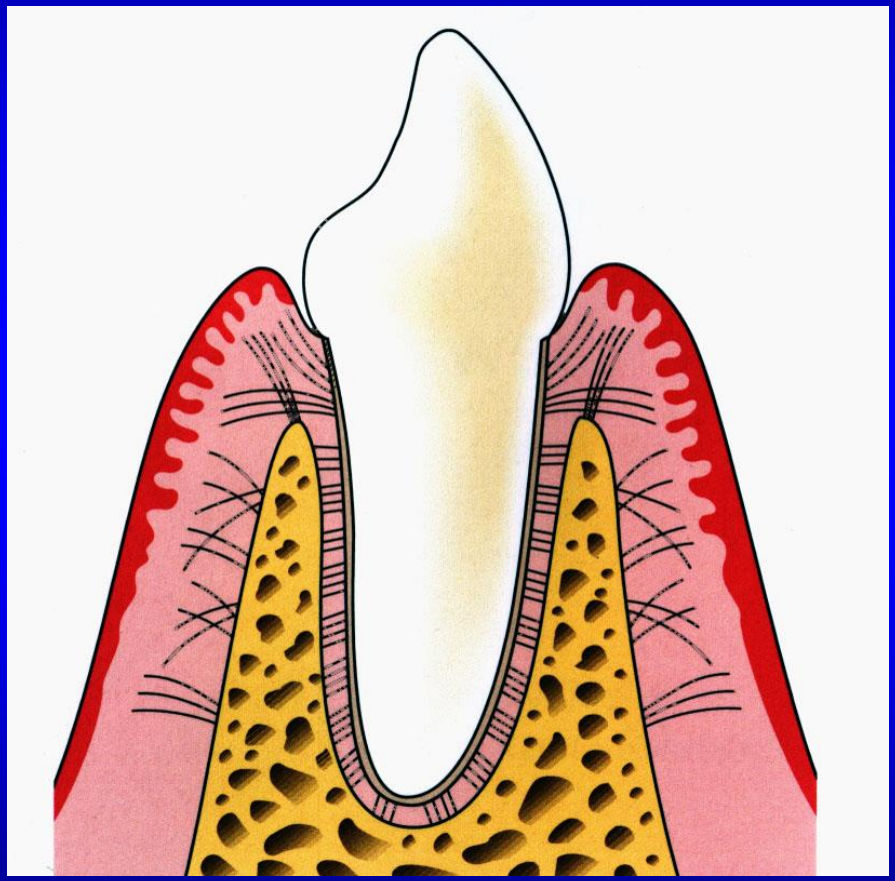
CONDITIONS OF SUCCESS OF THE ORAL IMPLANTS

- **Biocompatibility**
- **Gingival seal**
- **Optimal transmission of masticatory forces**

The different achorages of implant and tooth in the bone

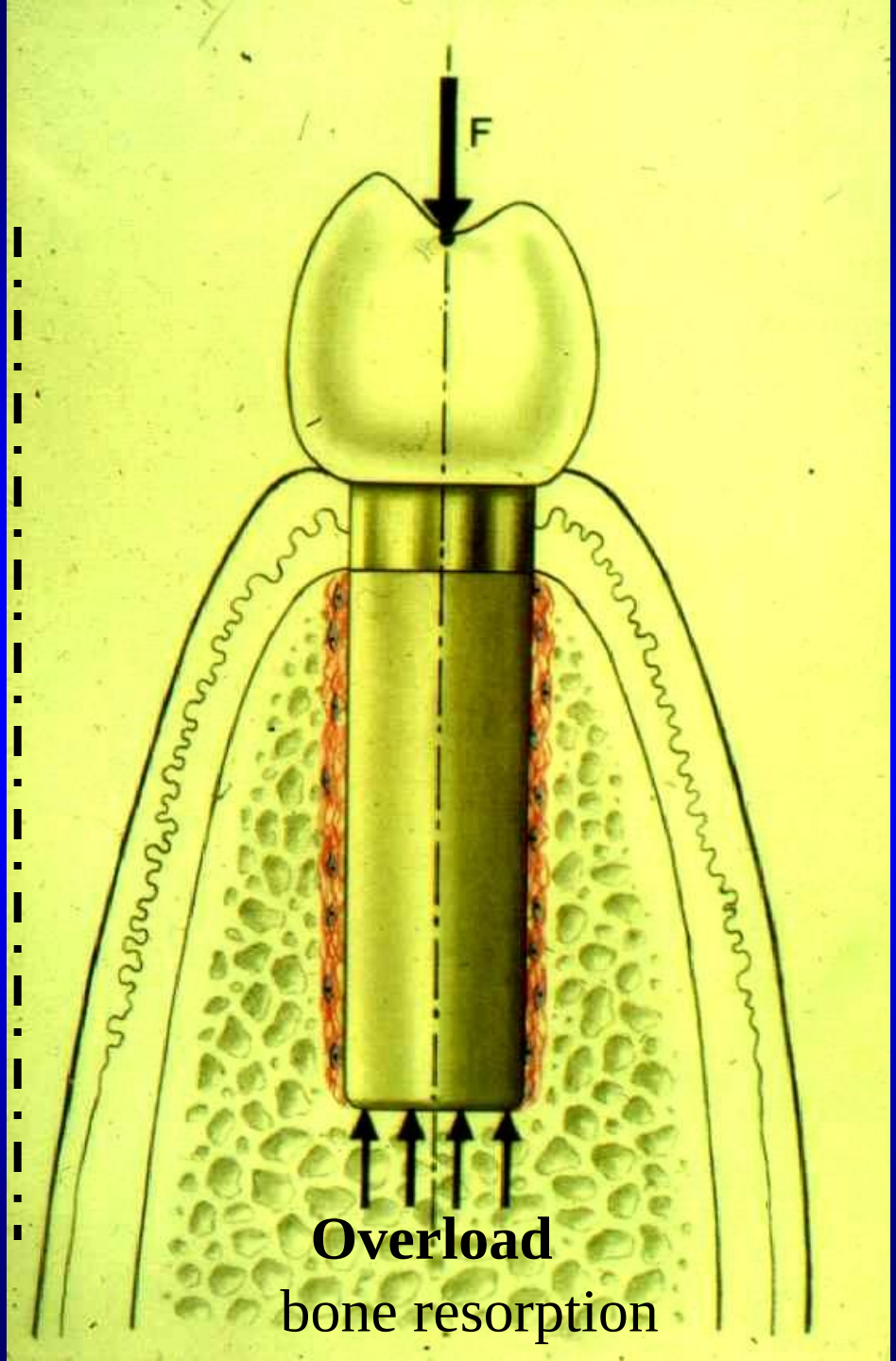




FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- **The way of healing**
  - **Bone properties**
  - **Implant material**
  - **Implant shape**
  - **Implant surface**
  - **Forces**

Transmission of forces in the case of fibrous healing

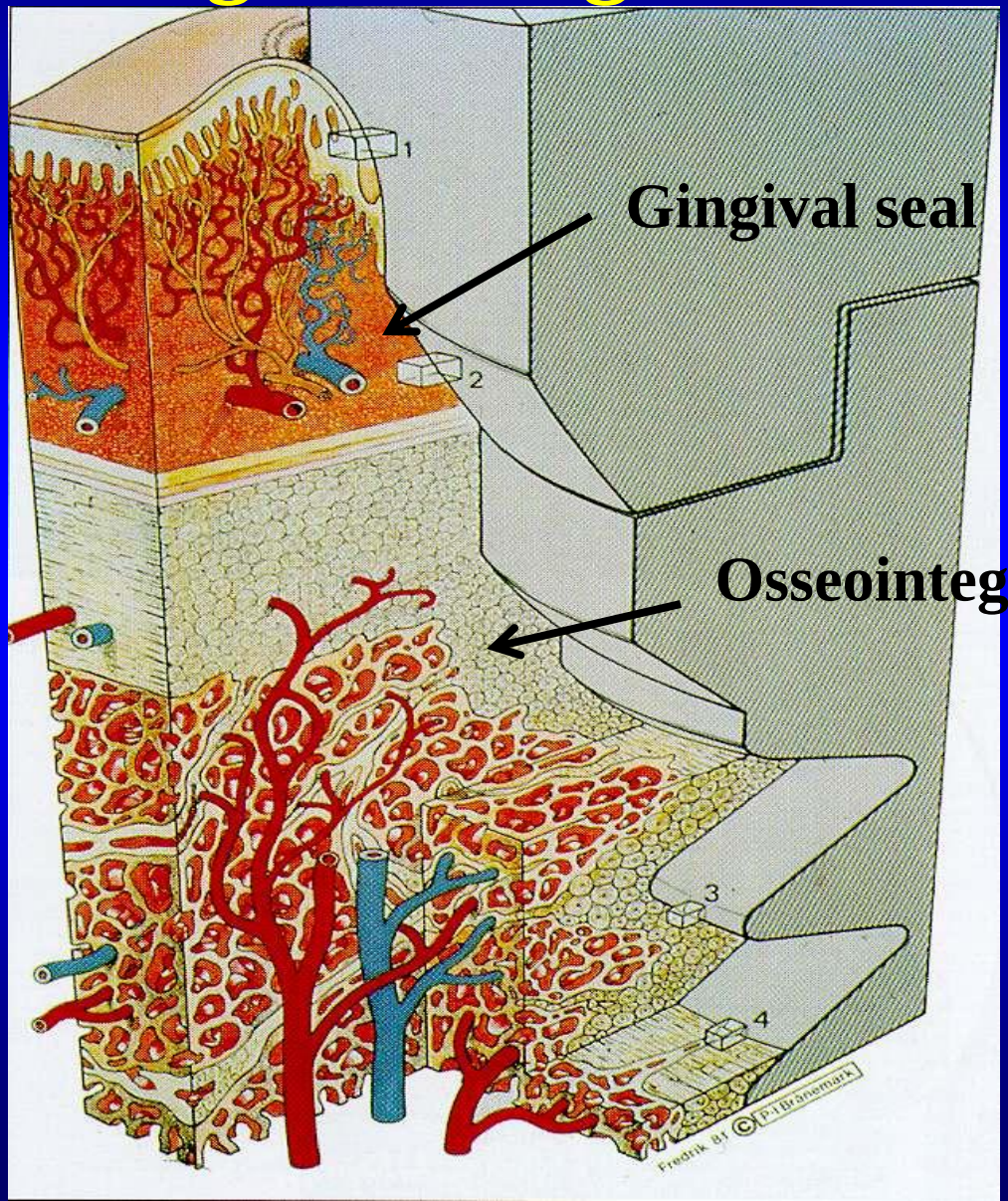


OSSEOINTEGRATION

Direct contact between implant and bone at light microscopic level

P.I.Branemark 1969, 1977

Connection between the implant and the neighbouring tissues



THE CONDITIONS OF OSSEOINTEGRATION

- Atraumatic, aseptic operation
- Bioinert or bioactive material
- Proper implant surface
- Primary stability
- Undisturbed (unloaded) healing?

FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- **The way of healing, the time of loading**
  - **Bone properties**
  - **Implant material**
  - **Implant shape**
  - **Implant surface**
  - **Forces**

When can be loaded the oral implants?

3-6 months, unloaded healing, is the condition of osseointegration

/ Bränemark et al.1977, Adell et al.1981, Albrektsson et al. 1981, Bränemark 1983, Bränemark et al. 1985, Albrektsson et al. 1986/

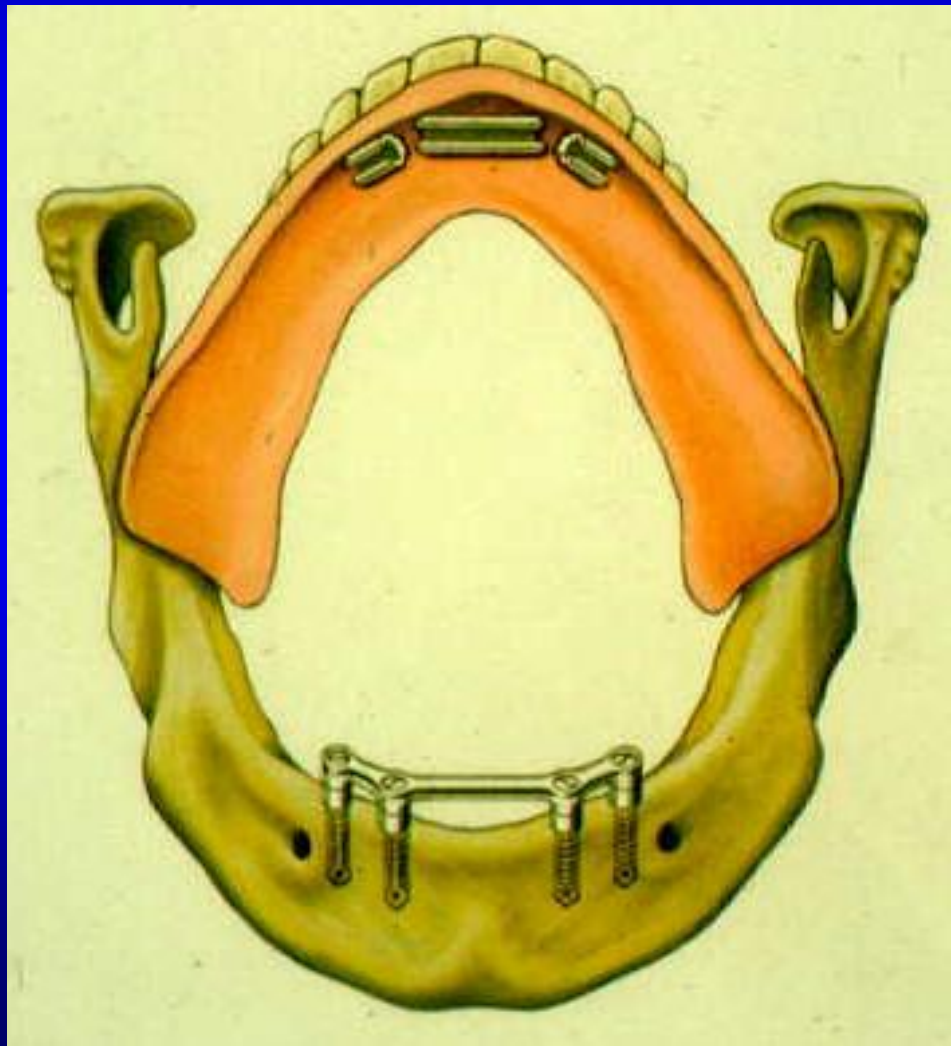
Ledermann P: **Stegprothetische Versorgung des zahnlosen Unterkiefers mit Hilfe von plasmabeschichteten Titanschraubenimplantaten.**

Dtsch. Zahnärztl. Z.

1979; 34:907

Study on 138 patients, 476 implants:

8,2% failures



The immediate loading promotes the „functional osteogenesis”

/Ledermann 1979/

The possible time for implant-loading, after insertion

/EAO 2006/

- **Immediate loading: within 72 hours**
- **Early loading: about 3 weeks after**
- **Conventional loading: 3-6 months after**

The possible time for implant-loading, after insertion

/ITI Consensus Conference 2008/

- **Immediate loading: within 1 week**
- **Early loading: after 1-8 weeks**
- **Conventional loading: after 2 months**

Immediate loading:

Loading in the initial stage of bone healing

The advantages of immediate loading

- Functional bone remodeling?
- Temporary prosthesis on the implants
- Shorter treatment time

The disadvantages of immediate loading

- The total or partial lack of osseointegration

The immediate loading is a therapeutical possibility, which depends on complex biomechanical conditions

The „micromotion”, tolerated by the bone:

50µm - 150µm

/rough implant surface/

/ Cameron et al. 1973
Geesink et al. 1987
Thomas et al. 1989
Lum et al. 1991
Soballe et al. 1993
Oonishi et al. 1994
Szmukler-Moncler et al. 1996/

The factors influencing the immediate loading:

- **Masticatory force**

Measuring the masticatory forces

- Molars **390-880 N**
- Premolars **453 N**
- Patients with total prosthesis **77-196 N**
- On implants max. **412 N**
-

The factors influencing the immediate loading:

- Masticatory force
- **The quality of bone**

primary stability=

The fixation of implant in the bone, during surgical placement

The insertion torque necessary for the success of immediate loading

> 40 Ncm /Horiuchi K. et al.: Int. J. Oral Maxillofacial Implants 2000; 15:824/

> 25 Ncm /Johansson P. et al.: Int. J. Oral Maxillofacial Implants 1994; 9:279/

The factors, influencing the primary stability of implants

- Quality of bone
- Form of the implant
- Technique of the insertion

The factors, influencing the primary stability of implants

- Quality of bone
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Misch C.E.: Bone character: second vital implant criterion, Dent. Today 39-40, June/July 1988.

D 1 bone density

composition

- compact

occurence

- atrophic mandible, interforaminal region

Implant-bone interface area ~ 80%

D 2 bone density

composition

- compact, porous cortical bone
- hard, roughly granular spongious bone

occurrence

- interforaminal and lateral region of mandible
- frontal region of maxilla

Implant-bone interface area ~ 70%

D 3 bone density

composition

- thin, porous compact bone
- fine, trabecular spongious bone

occurrence

- frontal region of maxilla
- posterior region of mandible

Implant-bone interface area < 50%

D 4 bone density

composition

- fine, trabecular spongious bone

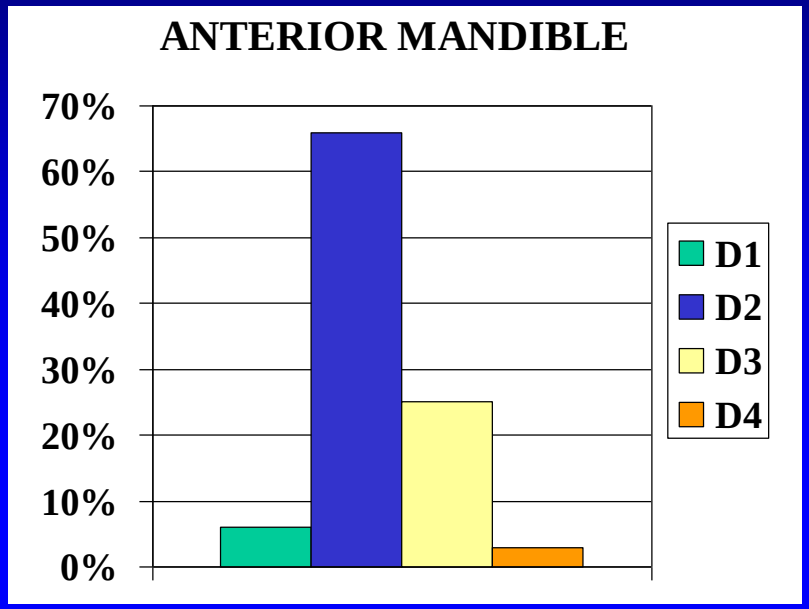
occurrence

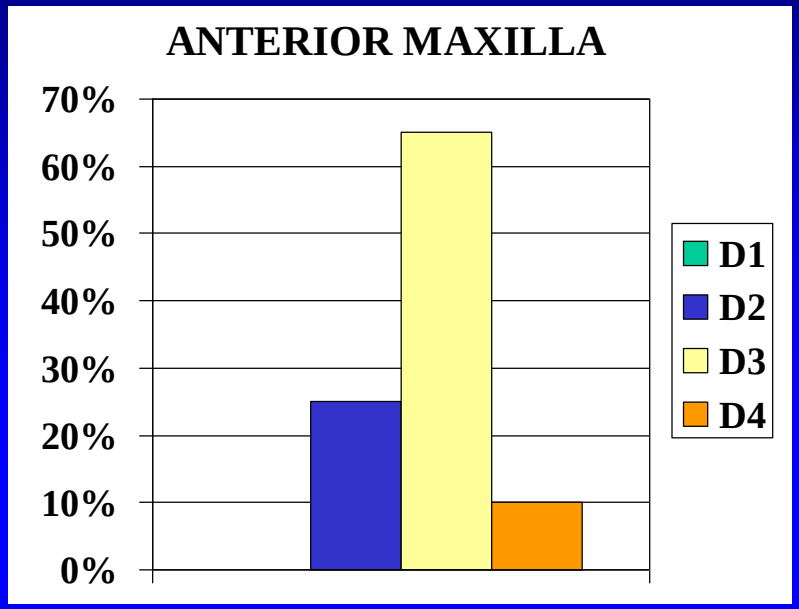
- lateral, posterior region of maxilla

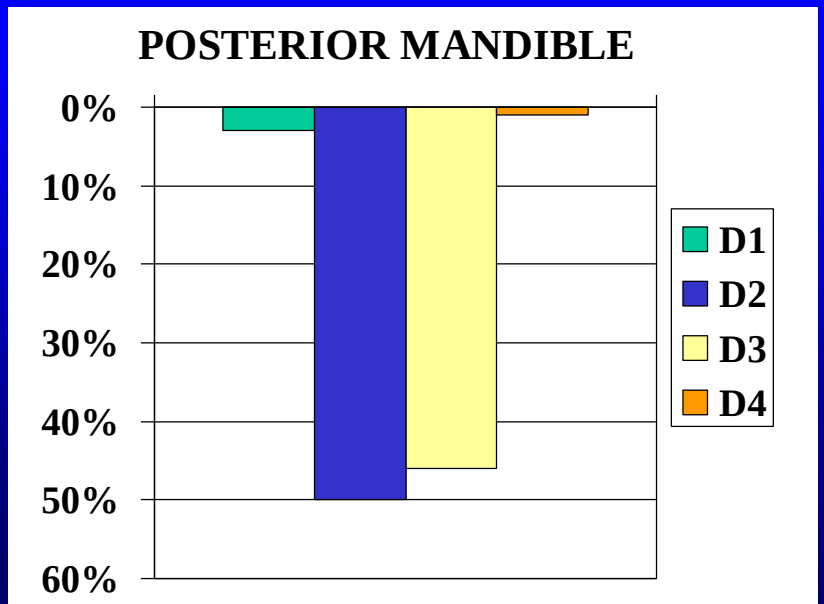
Implant-bone interface area ~ 25%

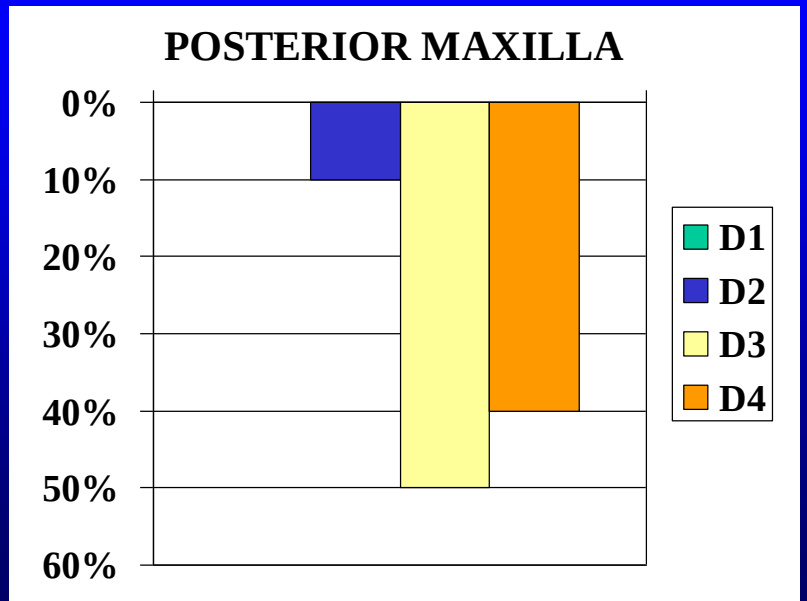
Distribution of bone quality in the jaws

/Misch C. E.: Contemporary Implant Dentistry 1999/





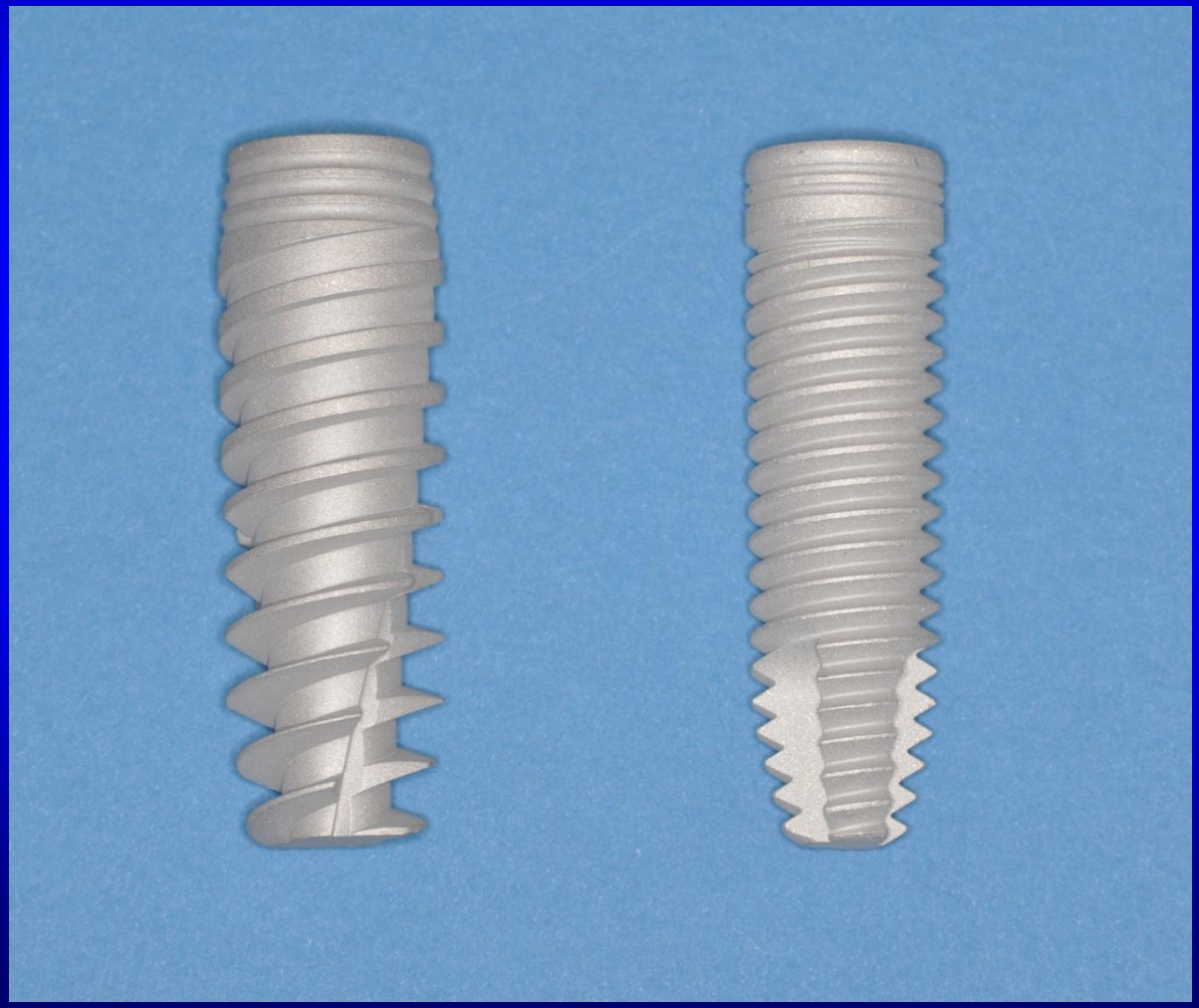




The factors, influencing the primary stability of implants

- Quality of bone
- Form of the implant
- Technique of the insertion

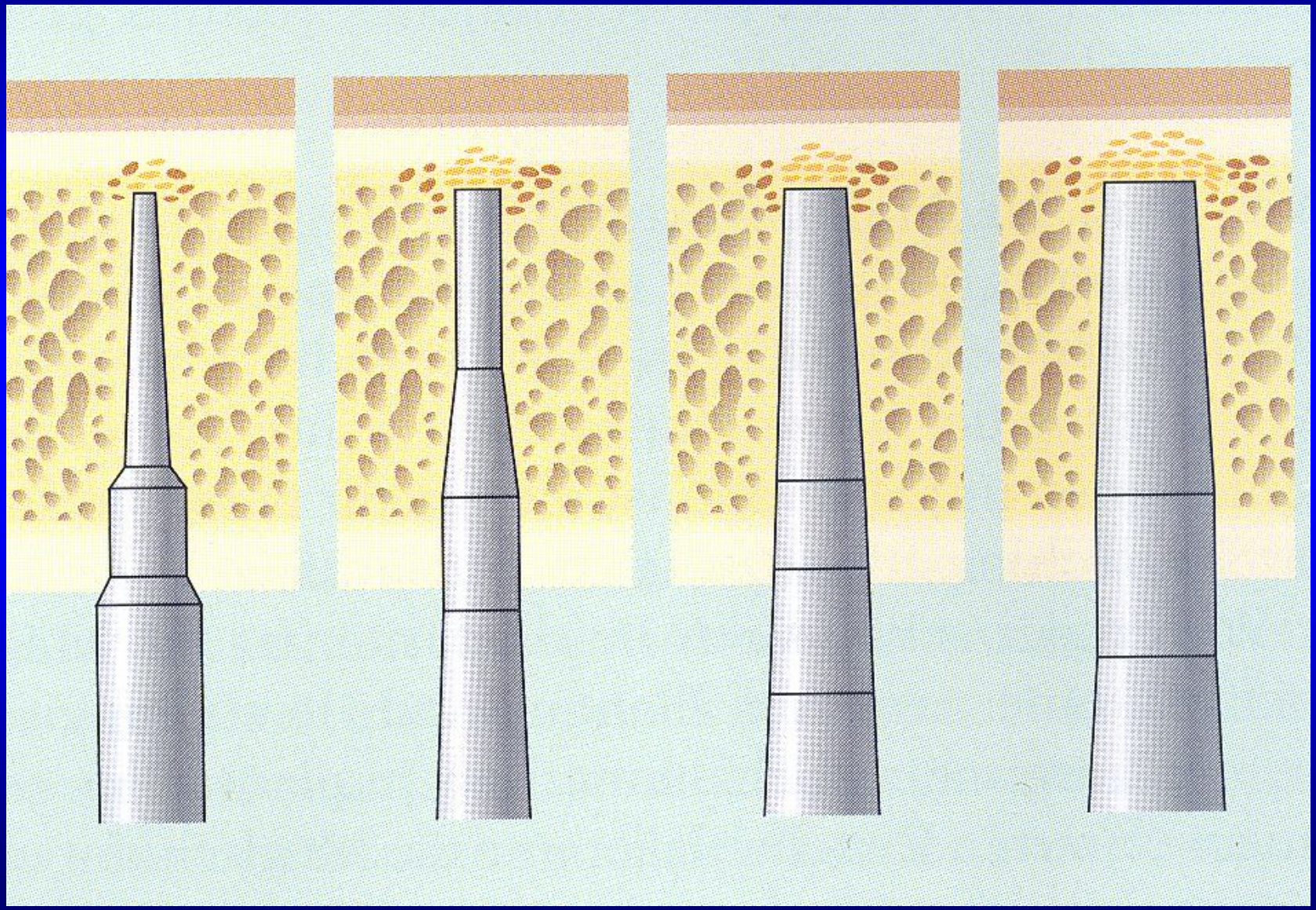
Different forms, different primary stability achieved



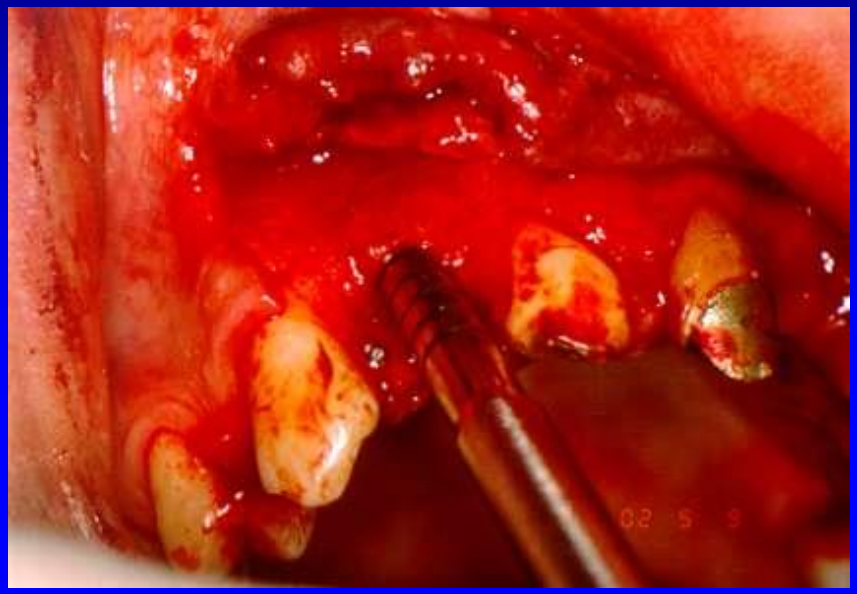
The factors, influencing the primary stability of implants

- Quality of bone
- Form of the implant
- Technique of the insertion

Bone condensation with Osteotome



Implant placement by Osteotome



The factors influencing the immediate loading:

- Masticatory force
- Quality of bone
- **Optimal load distribution**

OPTIMAL LOAD DISTRIBUTION

- maximal implant surface
- splinting of implants together
- balanced occlusion

The possible time for implant-loading, after insertion

/ITI Consensus Conference 2008/

- **Immediate loading: within 1 week**
- **Early loading: after 1-8 weeks**
- **Conventional loading: after 2 months**

Early loading:

Physiologic loading following the initial phase of osteogenesis

/about 3 weeks after implant placement/

The possibility for early loading means the acceleration of osseointegration by the modification of implant surface

Implant surfaces promoting the early loading:

• ITI-Straumann	SLA, SLActive
• Nobel Biocare	Ti Unite
• 3 I	Osseotite
• Ankylos	Ankylos – Plus
• Pitt – Easy	Puretex

primary stability=

the fixation of implant in the bone, during surgical placement

secondary stability=

fixedness of the implant after getting osseointegrated

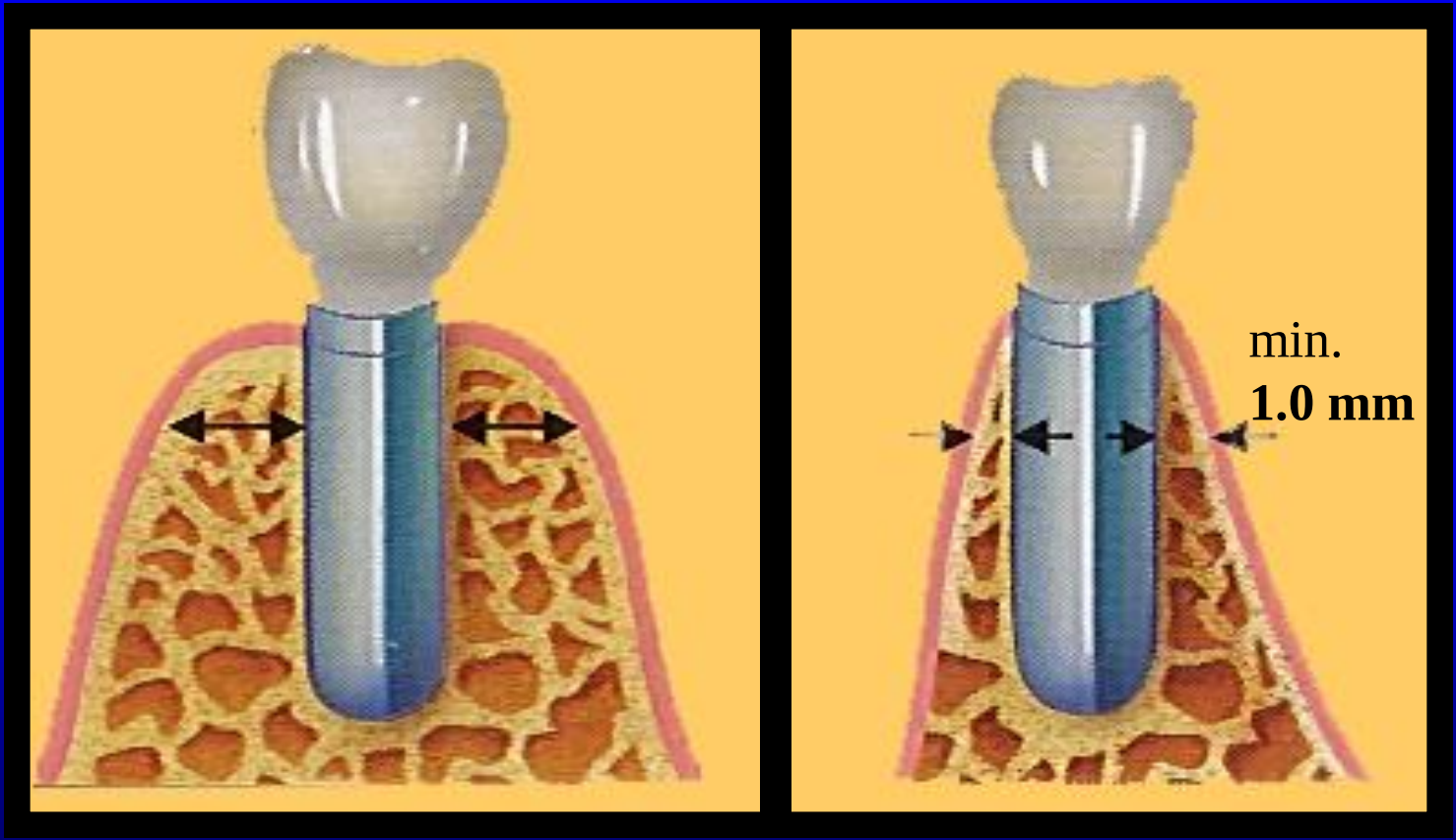
PROGRESSIVE OSSEOINTEGRATION

The bone-implant contact increases by the physiological remodeling of bone

FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- The way of healing
- **Bone properties**
  - Implant material
  - Implant shape
  - Implant surface
  - Forces

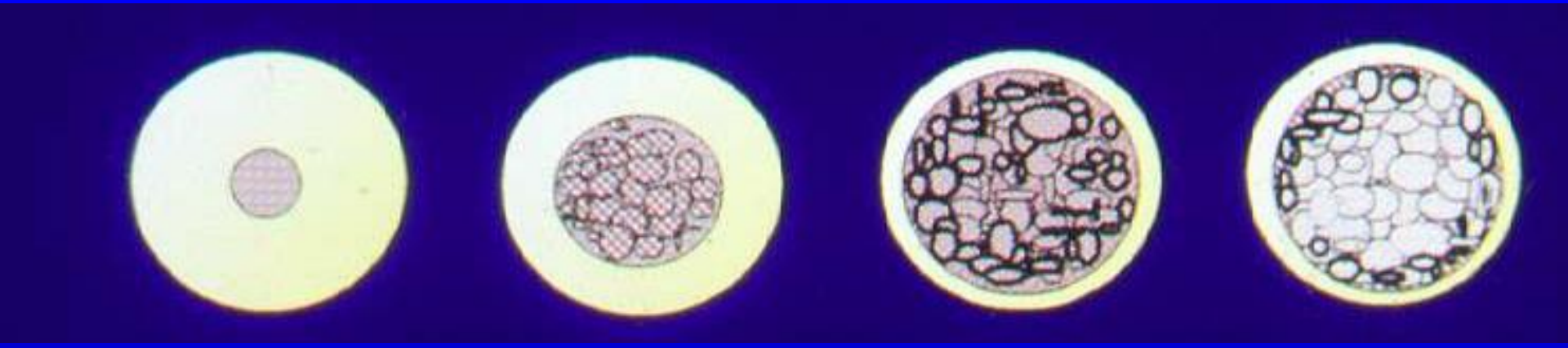
THE AMOUNT OF PERIIMPLANT BONE



ANATOMICAL STRUCTURE OF BONE

Classification of bone quality

(LEKHOLM, ZARB)



1. **2.** **3.** **4.**

FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- The way of healing
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  - Implant shape
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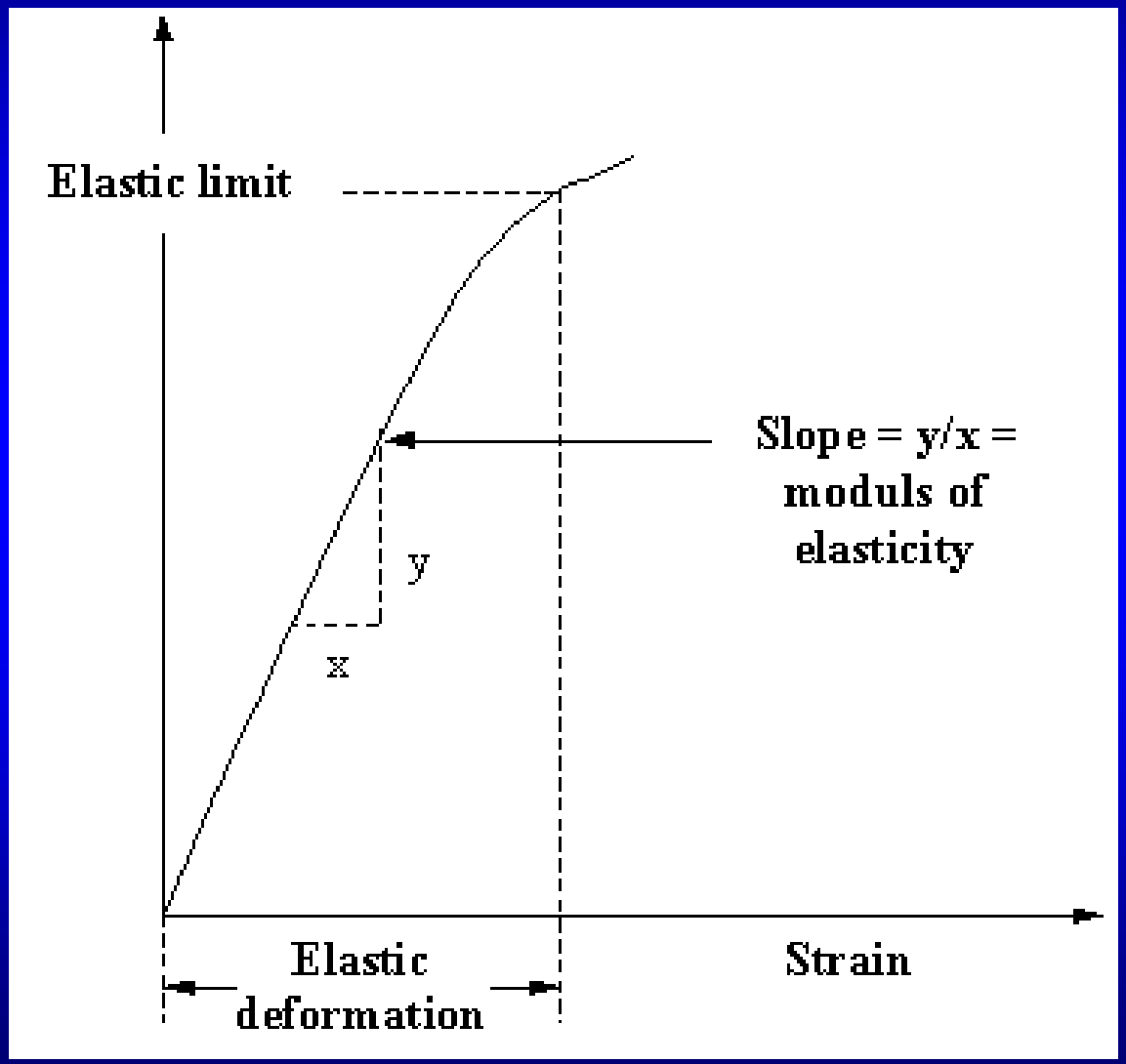
E-MODULUS



The relation of forces and strain

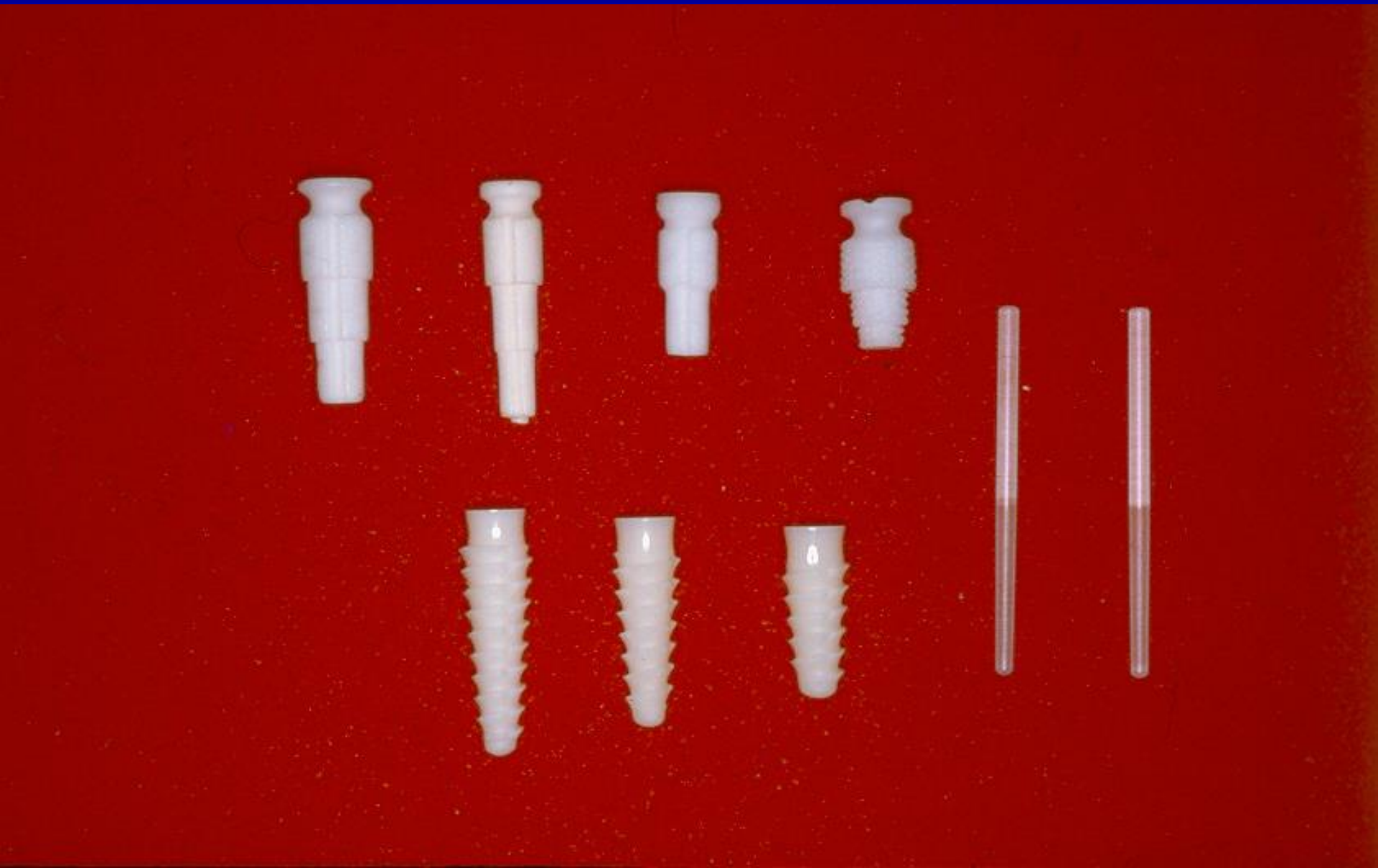
THE MECHANICAL PROPERTIES OF BIOMATERIALS I.

material	cortical bone	Au-Pt alloy	steel alloy 70Fe-18Cr--12Ni	cobalt alloy 66Co-27-Cr--7Mo
tensile strength (N/mm^2)	30-60	700-800	900-1500	900-1000
E-moduls ($10^3 N/mm^2$)	~20	100	200	250

THE MECHANICAL PROPERTIES OF BIOMATERIALS II.

material	cortical bone	Titanium	Tantalum	Al_2O_3 ceramics
tensile strength (N/mm^2)	30-60	600-1000	930	300
E-moduls ($10^3 N/mm^2$)	~20	120	180	350-400

ALUMINIUM-OXIDE BIOCERAMICS IMPLANTS



Aluminium-oxide implant healed

Crown restoration

Fractured
alumina
implant

FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- The way of healing
- Bone properties
- Implant material
- **Implant shape**
- Implant surface
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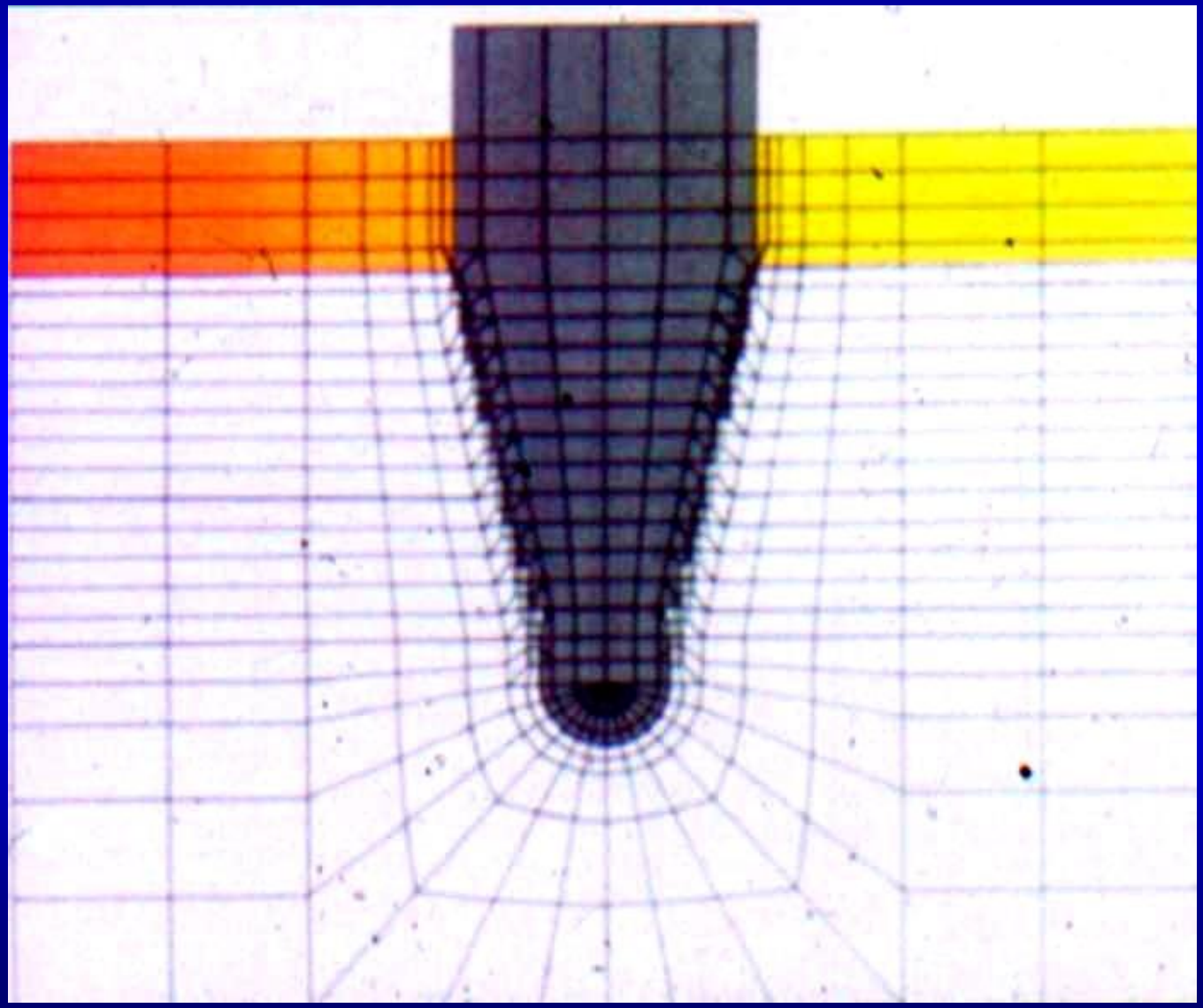
BIOMECHANICAL EXAMINATION METHODS

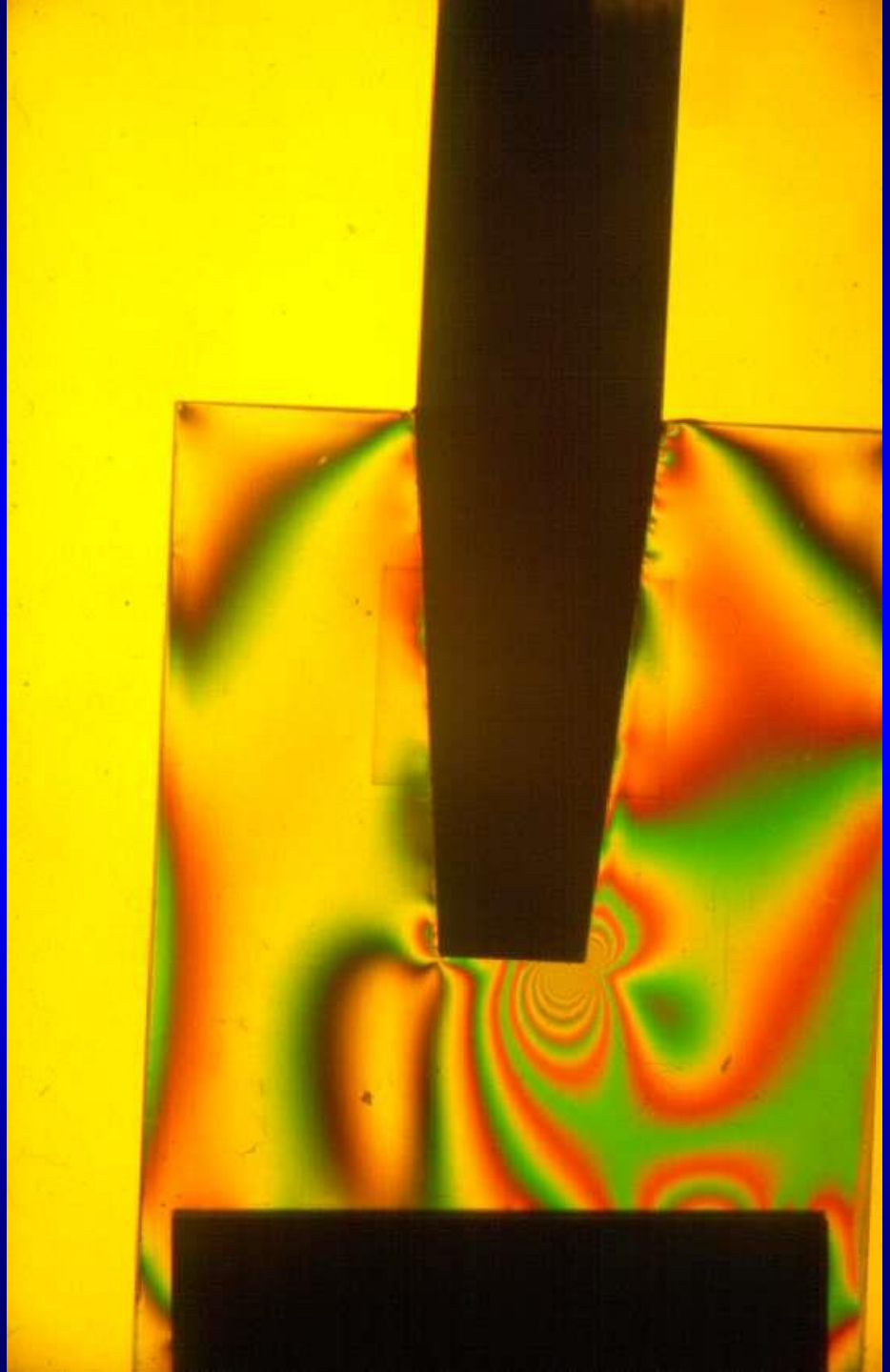
- **Finite element analysis**

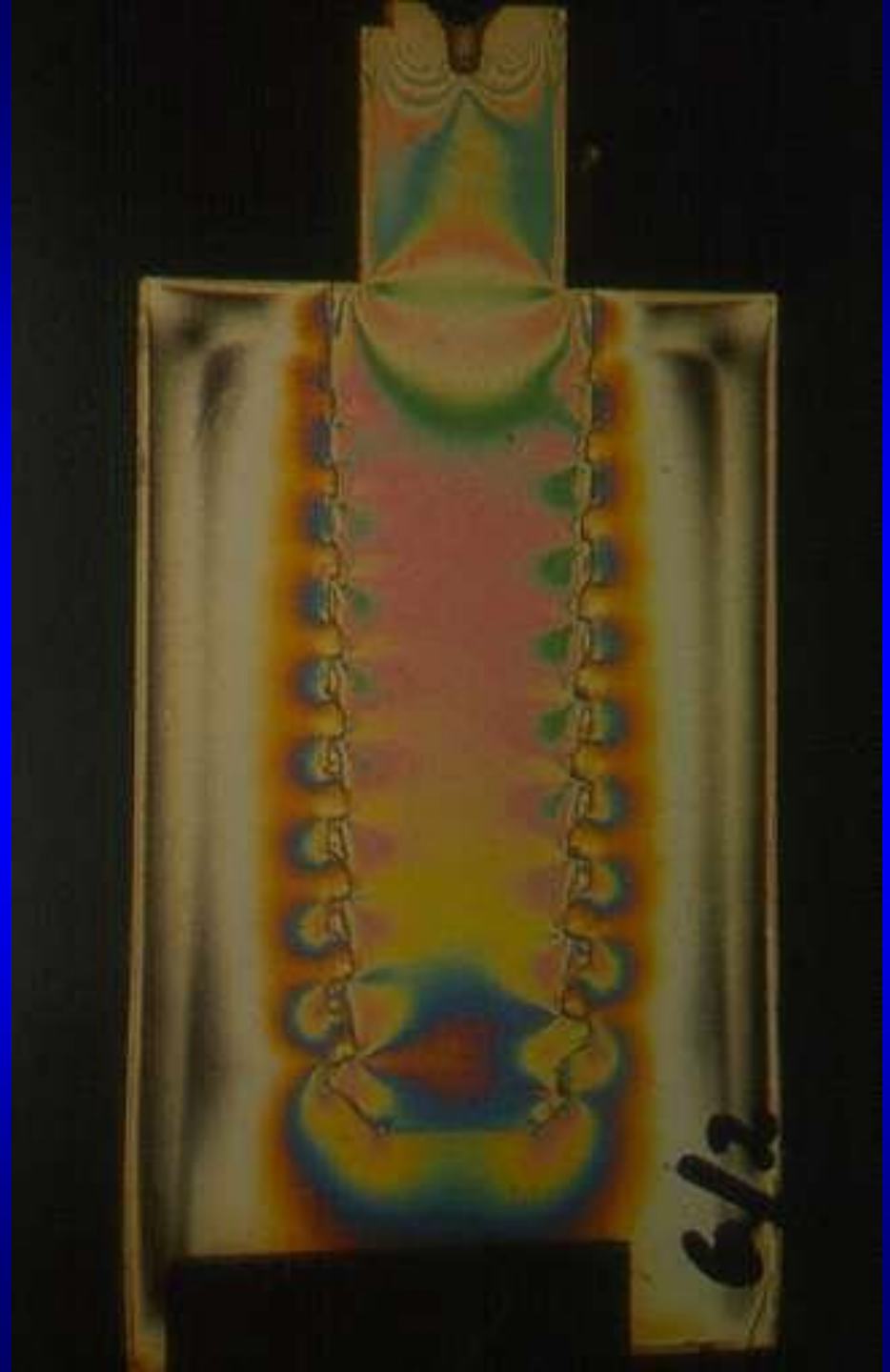
FINITE ELEMENT MODEL



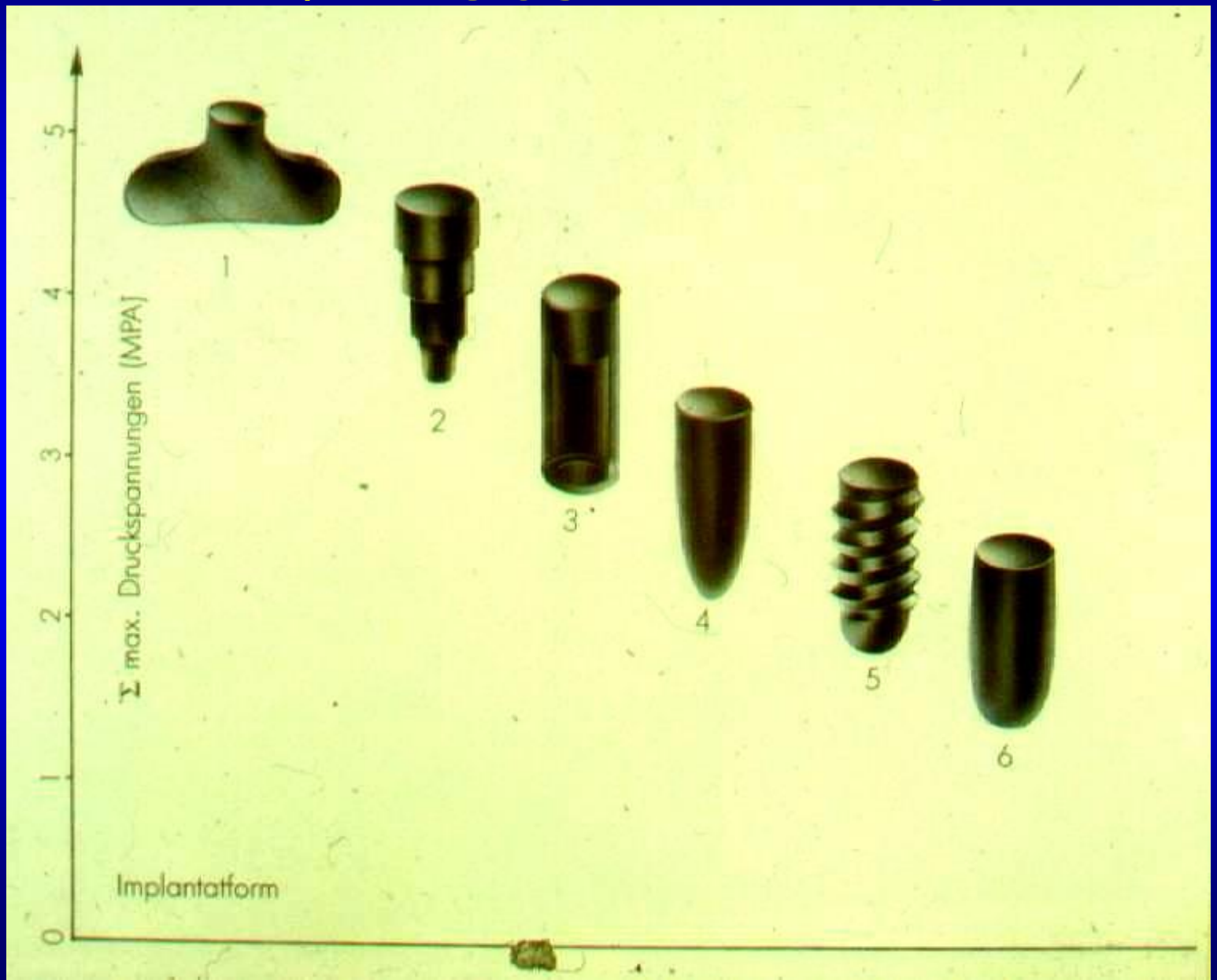
BIOMECHANICAL EXAMINATION METHODS

- Finite element analysis
- **Photoelasticity stress analysis**





COMPRESSIVE STRESS ON VARIOUS IMPLANTS



FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- The way of healing
- Bone properties
- Implant material
- Implant shape
- **Implant surface**
- Forces

MACROMORPHOLOGY

- **Biomechanically proper shape**
- **Implant volume**

MICROMORPHOLOGY

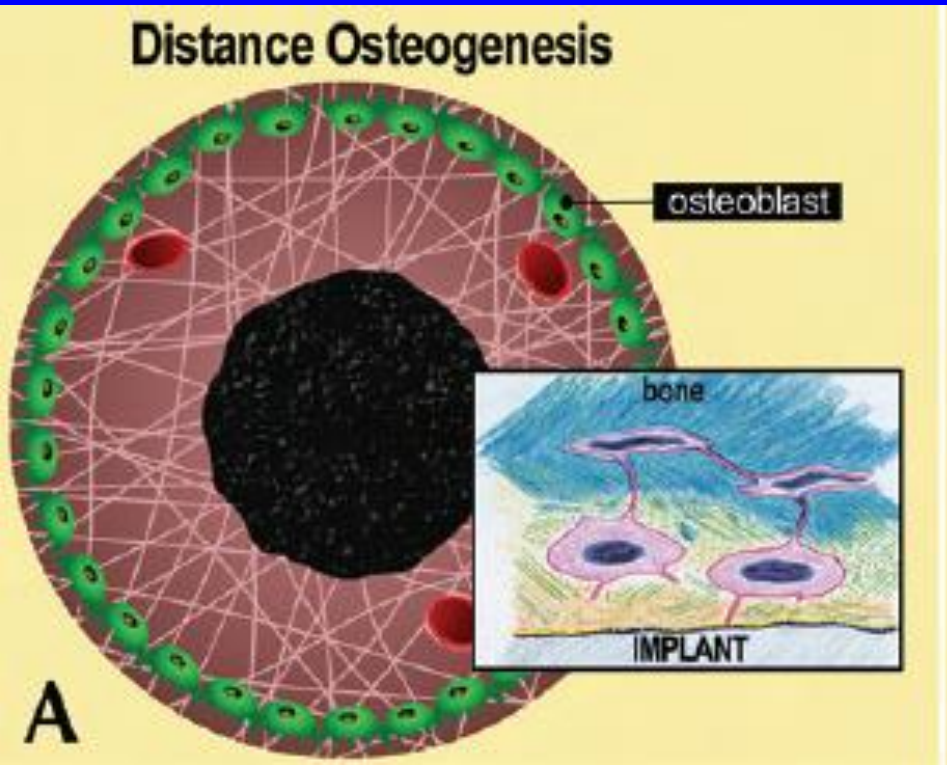
- Surface coating
- Surface roughness

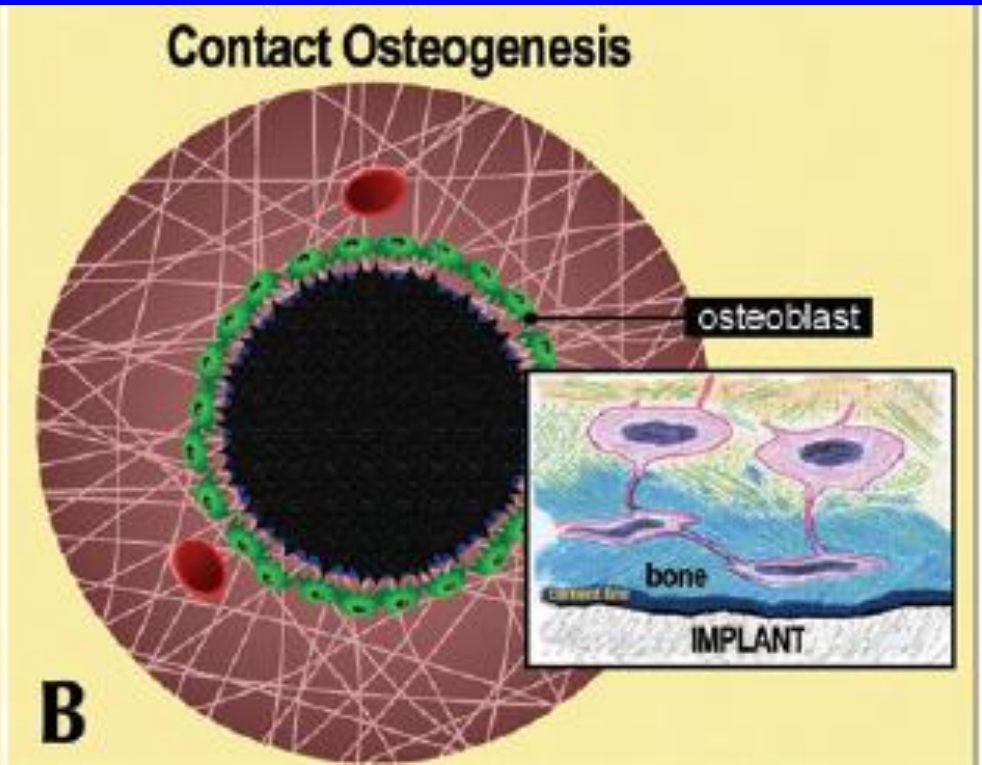
Osseointegration on the implant surface

/Osborn JF.,Newesely H.1980 ,Davies JE. 2005/

A: Machined surface :
bone formation
on the surface
of the old bone

B: Microtextured surface :
bone formation
on the surface
of the implant





FACTORS INFLUENCING THE ASSUMPTION OF LOAD OF ENDOSTEAL IMPLANTS

- The way of healing
- Bone properties
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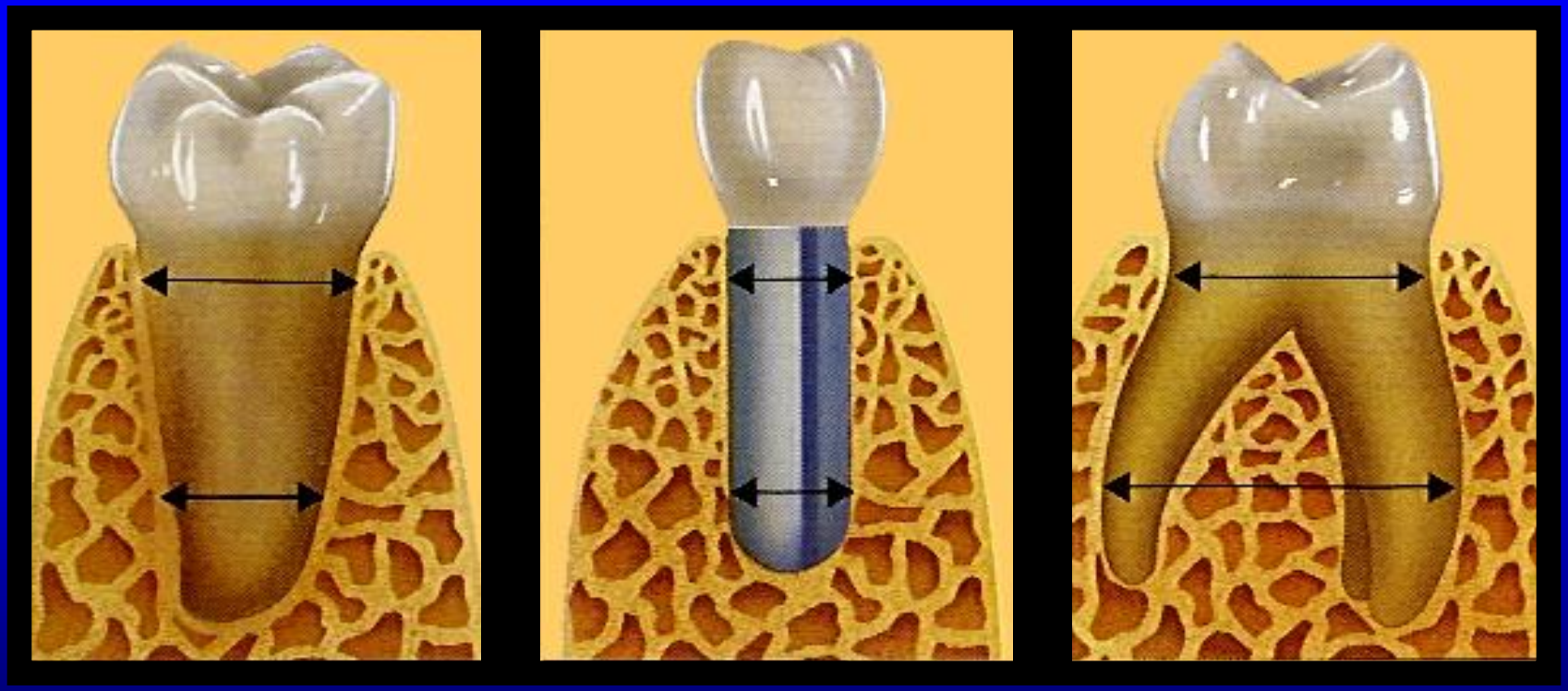
- Implant shape
- Implant surface

- **Forces**

The comparison of forms of implant and natural teeth



BIOMECHANICAL PRINCIPLES OF IMPLANT SUPPORTED PROSTHESES

- optimal distribution of load
- tensionless (passive) fit
- decrease of horizontal forces
- decrease of moment of rotation
- stress breaking, if possible