Providing a knowledge base for clinicians to possibly offer advanced implant-based treatments to their edentulous patients, thereby improving their patients’ quality of life.
Aging Population, Higher Life Expectancy

Population >65 years old

<table>
<thead>
<tr>
<th>Region</th>
<th>2005</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>23</td>
<td>43</td>
</tr>
<tr>
<td>North America</td>
<td>43</td>
<td>80</td>
</tr>
<tr>
<td>Europe</td>
<td>77</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: WHO and US Bureau of Statistics
Problems Associated with Conventional Complete Dentures

- Progressive ridge resorption and changes in facial support
- Inherent instability of prosthesis
- Intolerance of mucosal coverage, stomatitis and pain
- Reduced level of tongue motor control
- Variable levels of acquired neuromuscular control
- Full coverage of palate: inability to taste food and tissue soreness
- Reduced masticatory efficiency
- Emotional distress due to low stability on prosthesis
“An edentulous patient is an amputee, an oral invalid, to whom we should pay total respect and rehabilitation ambitions”

“The mouth is an extremely important part of the human body than medicine and controlling agencies recognize.”

P-I Brånemark
Implant Dentistry;
A Predictable Treatment Modality to Overcome the Biological, Functional and Emotional Problems Associated with Using Conventional Complete Dentures
Edentulous Alveolar Process: Residual Ridge Resorption (RRR)

Dental implants:
*can reduce bone resorption to normal physiologic levels*
Prosthetic options to treat an edentulous jaw?

1) Dentures
   - Conventional Complete Dentures (No Implants)

2) Implant-assisted Prostheses
   a) Removable Overdentures (Attachesments)
   b) Detachable IS-FDP (Metal-Acrylic or All-Ceramic)
   c) IS-FDPs (Conventional Bridges)
Implant-assisted overdenture: The most appropriate *first choice treatment* for edentulous mandibles

“There is now overwhelming evidence that a 2-implant overdenture should become the first-choice treatment for the edentulous mandible.”

*J Prosthett Dent 2002;88:123-124*
Rehabilitation of Edentulous Patients

Implant-supported Complete FDP

- Total retention and stability of prosthesis
- Optimal function and patient satisfaction
- Reduced mucosal coverage improving tolerance
- Adequate quality/volume of bone is required
- When alveolar ridge is considerably resorbed:
  1) Optimal position of teeth may not be feasible
  2) Esthetics/phonetic will be compromised
- Achieving good oral hygiene is difficult
Dental implants are able to **support** and **retain** prostheses

**Fixed Detachable Prostheses**

**Removable Overdentures**
<table>
<thead>
<tr>
<th></th>
<th>IS-Complete FDP</th>
<th>IS-Overdenture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load bearing</td>
<td>Implants</td>
<td>Implant-tissue</td>
</tr>
<tr>
<td>Retention/stability</td>
<td>Fully secured</td>
<td>Some movement</td>
</tr>
<tr>
<td>Occlusion</td>
<td>High biting force</td>
<td>Lower biting force</td>
</tr>
<tr>
<td>Prosthetic space</td>
<td>Less space needed</td>
<td>More space is required</td>
</tr>
<tr>
<td>Tissue coverage</td>
<td>Min. tissue coverage</td>
<td>Partial to full coverage</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Low maintenance</td>
<td>High maintenance</td>
</tr>
</tbody>
</table>
### Advantages of IS-Overdentures

<table>
<thead>
<tr>
<th></th>
<th>IS-Complete FDP</th>
<th>IS-Overdenture</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hygiene</strong></td>
<td>Fair</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>High fabrication cost</td>
<td>Lower Fabrication cost</td>
</tr>
<tr>
<td><strong>Appearance</strong></td>
<td>Partial Flange, Difficult transition line</td>
<td>Full flange, No transition line issue</td>
</tr>
</tbody>
</table>
Diagnosis and Treatment Planning

INTRA-ORAL AND EXTRA-ORAL EXAMINATIONS

IS - Complete FDP or IS - Overdenture
Critical Factors Affecting Our Decision

**IS-Complete FDP** vs. **IS-Overdenture**

1) Evaluation of missing hard and soft tissue

**Critical Equilibrium**

*Position of Maxillary Incisors:*

*Esthetics, Phonetics & Accessibility for Oral Hygiene*
Critical Equilibrium

Position of Maxillary Incisors:
Esthetics, Phonetics & Accessibility for Oral Hygiene

Maxillary Alveolar Process → Centripetal Resorption

More medially/palatally positioned alveolar crest
The position of maxillary incisors is chiefly governed by the position and expression of the lips, regardless of the position of ridge. Teeth are set outside of the existing resorbed ridge: Where They Used to Be.
Case Report
Violation of the Critical Equilibrium

No Prosthesis
Implants: Osseointegrated
Tooth Set-up, Try-in
Metal Framework

Notice the Position of the Framework Compared to Maxillary Alveolar Ridge
Good Aesthetics Result

Without upper prosthesis

With upper prosthesis
One of her main problems was her inability to clean under the maxillary prosthesis. The fixed partial denture was removed and the height of the flange area was reduced.
Accessibility for Oral Hygiene

1995

2005
Dissatisfaction, Remake

Repeating the Same Mistake
Same Problems, Continuous Complaint
Less Accessibility for Oral Hygiene

IPU, Faculty of Dentistry, U of T - 2011
Dissatisfaction, Remake

2005

2011
Intra-oral and Extra-oral Examinations

IS-Complete FDP vs. IS-Overdenture

Critical Factors Affecting Our Decision

2) Position of smile line vs. transition line

![Image showing smile line and transition line]
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

Critical Factors Affecting Our Decision

2) Position of smile line vs. transition line

- Gingival Tissue
- Transition Line
- Pink Acrylic (Labial Flange)
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

Critical Factors Affecting Our Decision

2) Position of smile line vs. transition line
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

Critical Factors Affecting Our Decision

2) Position of smile line vs. transition line
Intra-oral and Extra-oral Examinations

**IS-Complete FDP vs. IS-Overdenture**

Critical Factors Affecting Our Decision

2) **Position of smile line vs. transition line**

- **Patient with Resorbed Ridge**
- **Patient with Larger Ridge**
Intra-oral and Extra-oral Examinations

**IS-Complete FDP vs. IS-Overdenture**

Critical Factors Affecting Our Decision

2) Position of smile line vs. transition line
Failed Diagnosis and Planning

Oral Hygiene Problem
Intra-oral and Extra-oral Examinations

Proper Planning

Oral Hygiene

Phonetics

Esthetics
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

Critical Factors Affecting Our Decision

3) Available vertical restorative space
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

**Critical Factors Affecting Our Decision**

3) **Available vertical restorative space**

<table>
<thead>
<tr>
<th>Component</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teeth</td>
<td>&gt; 10 mm</td>
</tr>
<tr>
<td>Denture Base Resin</td>
<td>&gt; 2 mm</td>
</tr>
<tr>
<td>Metal Framework</td>
<td>&gt; 3 mm</td>
</tr>
<tr>
<td>Clearance for Hygiene</td>
<td>&gt; 1 mm</td>
</tr>
<tr>
<td>Total</td>
<td>&gt; 16 mm</td>
</tr>
<tr>
<td>Attachment</td>
<td>&gt; 4 mm</td>
</tr>
<tr>
<td>Total</td>
<td>&gt; 20 mm</td>
</tr>
</tbody>
</table>

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</table>
Intra-oral and Extra-oral Examinations

**IS-Complete FDP** vs. **IS-Overdenture**

Critical Factors Affecting Our Decision

3) Available vertical restorative space
Decision-making is based on:

1) Anatomic conditions & the shape of alveolar ridge
2) Quality and quantity of hard and soft tissues
3) Available vertical restorative space
4) Patients’ expectations
5) Financial considerations
Advantages and Disadvantages

IS-Overdenture Advantages versus IS-Complete FDP

- Fewer implants
- Less bone grafting is required
- Less specific implant placement
- Improved esthetics: Labial flange (acrylic)
- Better oral hygiene
- Nocturnal parafunction (remove prosthesis at night)
- Lower clinical and laboratory cost
- Easy repair
- Technically less demanding than fixed Prostheses
Advantages and Disadvantages

**IS-Overdenture disadvantages vs. IS-Complete FDP**

- Psychological (Overdenture is still a removable device)
- Immediate loading is not safe
- Greater restorative space is required
- More long-term maintenance will be required
- Attachments need to be frequently changed
- Continued posterior bone loss: Relines is required
- Prosthesis remake is required every few years
- Food impaction
- Prosthesis still moves on mastication
What Does the Clinical Evidence Say?

Mechanical Complications & Biological Complications

All-on-4 Design Prostheses
### Mechanical Complications

<table>
<thead>
<tr>
<th>Mechanical complications in Implant-supported FDP</th>
<th>Mean incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esthetic veneer fracture (porcelain)</td>
<td>14%</td>
</tr>
<tr>
<td>Acrylic base fracture (resin)</td>
<td>7%</td>
</tr>
<tr>
<td>Screw loosening (Total)</td>
<td>7%</td>
</tr>
<tr>
<td>Metal framework fractures</td>
<td>3%</td>
</tr>
<tr>
<td>Screw fractures (Total)</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical complications in Overdentures</th>
<th>Mean incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overdenture loss of retention/adjust</td>
<td>30%</td>
</tr>
<tr>
<td>Overdenture resin fracture</td>
<td>22%</td>
</tr>
<tr>
<td>Overdenture relines</td>
<td>19%</td>
</tr>
<tr>
<td>Clip/attachment fracture</td>
<td>17%</td>
</tr>
<tr>
<td>Overdenture fracture</td>
<td>12%</td>
</tr>
</tbody>
</table>

Biological Complications

All-on-4 and Angulated Implants: Does It Make Any Sense?
Biomechanical Principles in Implants

The Problem of Stress Distribution and Bone Loss

In-vitro Studies & Finite Elements Analysis
Biomechanical Principles in Implants

The Problem of Stress Distribution and Bone Loss

In-vitro Studies & Finite Elements Analysis
Axial vs. Non-axial Implants

It’s a matter of “EVIDENCE”

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>No. of patients</th>
<th>Observation time</th>
<th>No. of implants</th>
<th>Implant system</th>
<th>Factors</th>
<th>Finding for reconstruction</th>
<th>Finding for Implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sethi et al.</td>
<td>2002</td>
<td>38</td>
<td>10 y</td>
<td>3,101</td>
<td>Ankylos</td>
<td>From 0-45 degrees; 264 implants &gt; 15 degrees, 352 implants ≤ 15 degrees</td>
<td>Survival probability for implants NS</td>
<td>No information on prosthetic complications</td>
</tr>
<tr>
<td>Koutouzis and Wennström</td>
<td>2007</td>
<td>38</td>
<td>5 y</td>
<td>69</td>
<td>Astra Tech</td>
<td>36 axial (0-4 degrees inclination) versus 33 nonaxial (12-30 degrees)</td>
<td>No increased risk of technical complications</td>
<td>No influence on bone loss around implants</td>
</tr>
</tbody>
</table>

NR = not recorded; NS = not significant.

Long-term survival of tilted Implant $^2$:
3101 tilted implants, 10 years follow up → %97.5 survival

Correlation between bone loss and Implant angulation $^3$:
111 implants, 5 years → NO CORRELATION

Tilted implants in the immediate loading rehabilitation of the maxilla: a systematic review - 2012

Axial vs. Tilted Implants

Axial vs. Tilted Implants

The fate of marginal bone around axial vs. tilted implants: a systematic review - 2014

“The use of tilted implants to support fixed partial and full-arch prostheses for the rehabilitation of edentulous jaws can be considered a predictable technique, with an excellent prognosis in the short and mid-term.”

(97.9% survival after 1 to 3 years)

Biomechanics and Implant Dentistry

Tilted Implants, Cantilever Segments and Mechanical Complications of IS-Complete FDP
Biomechanical Concepts:

Are essential when it comes to “prosthetic components”; but, not directly relevant to biological complications (i.e. Bone loss) and implant survival.
New 3D technologies applied to assess long-term clinical effects of misfit of the full jaw fixed prosthesis on dental implants

30 Patients, Edentulous Mandible, 19 years Follow Up
Restored Between 1980 and 2000
New 3D technologies applied to assess long-term clinical effects of misfit of the full jaw fixed prosthesis on dental implants.

Effect of Framework Misfit (within 95 to 232 μm) After 19 years

1) No effect on bone loss

2) More screw loosening/fractures
All-on-4 with Cantilever Segments: Does It Make Any Sense? Is It A New Idea?
Long-term Complications Associated with Implant-supported Complete Fixed Dental Prosthesis

*Edentulous Patients, 19±6 Years Follow Up*
Long-term Complications Associated with Implant-supported Complete Fixed Dental Prosthesis

Bone Loss

Anterior (Medial) Implant vs. Longest Cantil. Implant

Paired t-test: Significantly (P=0.01, 95% CI: 0.31 to 1.07) higher bone loss around the most anterior implants (medial positions)

→ Tensile stress on the most anterior implant (medial position)
→ Naturally thinner alveolar ridge in the anterior medial position
Long-term Complications Associated with Implant-supported Complete Fixed Dental Prosthesis

Effect of Cantilever Length on Bone Loss

No detrimental effects caused by ICFDPs on marginal bone levels around implants in the proximity of cantilever segments

Cantilever Length and Bone Loss → No Correlation \( (r = 0.164) \)

No detrimental effects caused by ICFDPs on marginal bone levels around implants in the proximity of cantilever segments
Brånemark Smooth Surface Implants

The Second Implant Patient in North America
Toronto Study Case

Pl. Brånemark, G. Zarb 1979 (Follow-up → 2013)
A Historical Controversy

Etiology of Marginal Bone Loss Around Implants
The role of occlusal forces on the marginal bone loss is unclear and controversial.³

Is it because of OCCLUSAL OVERLOADING?
Mechanical stress beyond the physical limits of bone cause long-term bone loss around implants.¹

Is it because of MICROBIAL FACTORS?
Bacterial contamination of the gap between the implant and the abutment can lead to bone loss.²

Systematic Review of the Literature:
The role of occlusal forces on the marginal bone loss is unclear and controversial.³

Microgap Between Implant and Abutment

Microgap & the concept of platform-switch

Occlusal forces on the implant cause a *pumping effect* (depending on the type of connection at the interface) resulting in a *flow of bacteria* from the gap.

**Platform switching**

A larger-diameter implant is combined with a narrower abutment, resulting in the movement of the implant-abutment gap away from the implant shoulder.
The State of the Problem: Microgap Between Implant and Abutment

1) Before Lateral Loading
2) After Lateral Loading
The State of the Problem: Microgap Between Implant and Abutment
Chewing Forces
(As Large as 200 N)

Elastic Deformation

Micro-Movements

Sheer-forces at Bone-implant Junction
Implants Were All Attached

→ No Microgap