Immediate loading

Definition
Stabilization vs. Osseointegration
Histological Outcomes
Clinical Outcomes
Implant Design
Transitional Implants
Technique
Conclusions

2002년 Spain의 Barcelona에서 열렸던 Immediate Loading 에 관한 Consensus Meeting 에서 Definition 이 확정되기 전까진 미국과 유럽의 Immediate loading 과 immediate function에 관한 정의는 서로 완전히 상반된 것이었다.

Today’s Definition of immediate loading after the 2002 consensus:
A procedure in which dental implants are subjected to Functional Occlusal Forces / loads coincident with the date on which the surgery to place them was performed.

Immediate loading 에 관해 다음 네 가지 상황을 고려해 볼 수 있다.
1. immediate temporization without occlusion
2. immediate temporization in occlusion
3. immediate socket placement without occlusion
4. immediate socket placement with occlusal loading

표 1-1 은 immediate loading 을 위해 반드시 이해해야만 하는 도표다. a, b, c 선이 % of osseointegration line 과 만나는 곳은 initial stabilization이 osseointegration의 힘으로 넘어가는 지점이다. 여기서 type III bone에 주의해야 한다. 왜냐하면 초기의 biologic width 형성 후 첫 번째 thread 까지 bone 이 흡수되면 약한 marrow 쪽의 bone 만 남기 때문이다. 그러므로 type III bone 에서는 supracrestal 로 implant 를 위치시킬 수 있도록 해야 한다.

<table>
<thead>
<tr>
<th>&quot;Consensus 이전&quot;</th>
<th>Immediate Loading</th>
<th>Immediate Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>In occlusion</td>
<td>Out of occlusion</td>
</tr>
<tr>
<td>Europe</td>
<td>Out of occlusion</td>
<td>In occlusion</td>
</tr>
</tbody>
</table>

Initial stabilization을 높이는 3가지 방법은
1) dense bone에 심는다.
2) wedging force를 위해 tapered implant를 심는다.
3) “go around the turn”
즉, straight line splint가 아니라 U-shaped splint로 한다.

Straight line splints는 mesiodistal force에 강한 buccolingual force에 약하다. 약 150 μm 이상의 lateral force가 있을 시 osseointegration이 일어나지 않는다. 그러므로 M/D, B/L force에 저항할 수 있는 U-shaped splint를 해준다.

Immediate loading에 관한 몇 가지 literature review를 해보도록 한다.
1. The effects of early occlusal loading on One-stage Ti-Alloy implants in beagle dogs: A pilot study
   Sagara M, JPD 1993; 69:281–288

Submerged case에서 더 나은 BIC를 보여주었다.

2. Immediate loading of Ti-plasma-sprayed implants: An Histological Analysis in Monkeys
   -monkey study
   -48 TPS (24 Maxilla, 24 Mandible)
   -24 test (loaded), 24 control (unloaded)
   -9 months
   -Histomorphometric analysis
   -BIC (bone to implant contact)

-1번 연구와는 달리 loading을 가한 test group에서 더 나은 BIC를 보여주고 있다.

3. Histological and Histomorphometrical implant bone subjected to immediate loading: An experimental study with Macasa fascicularis
   - Romanos GE, Toh CG, Siar C
   - IJOMI 17; 44–51, 2002

BIC는 immediately loaded case와 delayed case에서 별다른 차이를 보이지 않았으나, BA(bone around implant within the threads)에서는 immediately loaded case에서 더 많은 % bone을 보여주었다.

4. Immediate fixed interim prosthesis supported by two-stage threaded implants: Methodology and Results
   - Schnitman P, Wohlr B, Rubenstein J
   - J Oral Implantol 1990; 16; 96–105

   - N=7 patients
   - 47 Nobelpharma Implants
   - 26 implants submerged in anterior mandible
   - 4 months submerged period
   - 21 implants loaded to support interim prosthesis
   - 1 immediately loaded molar region fixture failed at 3 months
   - 1 immediately loaded molar region fixture failed at 6 months
   - 1 immediately loaded molar region fixture failed at 21 months

   - Potential cause for immediate implant failure
     - inadequate implant length
     - poor bone quality (as per Schnitman)
   - 18 still integrated

위에 열거된 서로 상반된 연구결과로 본인은 자체적
으로 Immediate loading에 관한 다음과 같은 새로운 실험을 하게 되었다.
1) Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1 to 5 year date
   • Tarnow DP, Emtiaz S, Classi A
   • IJOMI 12: 319–324, 1997

   • 10 patients
   • 6 mandibular cases (64)
   • 4 maxillary cases (43)
   • Total loaded: 69
   • Total submerged: 38
   • Total # placed: 107
   • Failed

   2 immediate loaded
   (이 두 case 모두 interim prosthesis를 한 경우임)
   1 submerged

본인은 case가 진행됨에 따라 좀 더 자신 있게 immediate loading의 수를 늘리게 되었다. 또한 Maxilla의 경우도 예외가 아니며 implant type에 따른 차이도 없는 것을 볼 수 있다.

2) Implant−retained mandibular overdentures with immediate loading:
A Retrospective multicenter study on 226 consecutive cases
   • Chiapasco M, Markwalder TH
   • COIR: 8:48–57, 1997

   • 226 patients, 904 Implants (4/implant)
   • 4 systems (TPS, ITI, HA−Ti, NLS)
   • Impression immediately after surgery
   • U−shaped gold bar inserted next day
   • Clips mounted and denture inserted same day
   • Average follow up 6.4 years
   • Implant success 96.9%, Bar success 98.5%

여기서 Dr. Tarnow는 bar는 class III malocclusion에서 maxillary case를 제외하고는 이제 잘 쓰지 않는다고 함.

3) The use of transitional implants for immediate fixed temporary prostheses in cases of implant restorations
   • From S, Emtiaz S, Tarnow D
   • Pract Perio Aesthet Dent ; 1998; 10(6) 737–746

   • 78 transitional implants in 15 patients
   • 6 failed (3 in one patient)
   • 3 were mobile but remained in function
   • no prostheses were lost
   • failure due to early prosthesis removal

정확한 Surgical Template를 만들고 2mm twist drill로 깊이 5mm까지 drilling 한 후 drilling 한 위치에 attached gigniva가 있을 경우 flapless surgery를 한다. punch를 사용하는 경우는 임종의 flap이므로 flapless surgery라 할 수 없다.
다음과 같은 경우에 out of occlusion 시켜준다
immediate temporization without occlusion
1) One stage surgery with a healing abutment
2) Single crown
3) Straight line splints

Immediate socket placement without occlusion
1) when the socket is filled by the implant
   (1.5mm rule)
2) full arch case only or 4 on floor splinted

Conclusion

1) Full arch cases only for occlusally loaded cases
2) Or 4 on the floor splinted with a bar
3) Non-occlusally loaded with immediate
temporization for cases with good initial
stabilization (type I & II bone)
4) Immediate socket implants should be utilized
with caution for immediate occlusally loaded
cases
5) Success will depend on
   length of implant in bone
density of bone
width of the implants
distribution of the implants
   (turn in the arch and AP spread)

Tips for immediate occlusal loading
1) For Full arch case only
2) Use minimum 10mm implants
3) Use diagnostic wax−up for template and
   provisional
4) Use rigid metal casting in lingual of provisional
   (if there are long spans)
5) Use screw retained provisional
6) If cemented, do not remove provisional for 8 +
   weeks
7) All implants must have high initial stability
   (tongue, ISQ, periotest)
8) Utilize widest A-P distribution of implants

Sinus lift

▶ NYU sinus study database
▶ Evidence−based decision making
   Effect of time
   Effect of graft materials
   Effect of membranes
   Effect of implant surface
   Interactions

NYU Sinus Study (1993−July 2003)
797 Sinus lifts (517 patients)
1461 implants placed
395 histological cores

Effect of time on sinus graft healing
1) Histological evaluation of the sinus elevation
   procedure: A clinical report
   • Wallace et al
   • Int J Rest Dent 1996; 16; 46−51
   • 4 sinus cores from the same subject
     80% Osteograf/N, 20% Autogenous
     Cores at 4, 8, 12 20 months
     Histomorphometric analysis done independently by different university & not
     supported by any company

<table>
<thead>
<tr>
<th># months</th>
<th>4</th>
<th>8</th>
<th>12</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>% vital bone</td>
<td>15%</td>
<td>33%</td>
<td>38%</td>
<td>65%</td>
</tr>
</tbody>
</table>

2) Effect of time on graft maturation
   • Froum et al
**Effect of graft material**

1) Human histologic evidence of integration functionally loaded hydroxyapatite-coated implants placed simultaneously with sinus augmentation: A case report 2.5 years post placement

   Rosenlicht J, Tarnow D
   J Oral Implantol 1999: 25:7-10

2.5년 후 일부 graft material (bovine bone)은 bone 과 완전히 integration된 상태로 남아 있으며 implant 주변엔 bone 과 marrow 만이 접해있다

   (bovine bone graft material은 주변에 접해남아있지 않는다)

2) Histologic evaluation of Bio-Oss in a 2 stage sinus floor elevation and implantation procedure: A human case report

   Valentini P, Abensur D, Densari D
   COIR 1998: 9:59-64

   Area densities of the mineralized bone at 6 month

<table>
<thead>
<tr>
<th></th>
<th>Area density of bone</th>
<th>Area density Bio-Oss</th>
<th>Area density Bone marrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-grafted area</td>
<td>27</td>
<td></td>
<td>73</td>
</tr>
<tr>
<td>Grafted area</td>
<td>28</td>
<td>28</td>
<td>44</td>
</tr>
</tbody>
</table>

Area density of bone은 어떤 research paper든, 어떤 material 을 쓰는가에 상관없이 일정하게 25-30% 정도로 나온다. Grafted area에서 Bio-Oss가 bone marrow space를 차지하고 있는 것은 좋은 점이다.

결론적으로 반드시 Mineralized bone를 사용해야만 한다. (human bone이나 bovine bone 어느 쪽이나 무방하다)

3) Sinus Grafting with porous bone mineral (Bio-Oss) for implant placement:

   A 5 year study on 15 patients

   Valentini P, Abensur D, Schenk R et al

   20 sinuses, 15 patients

   100% Bio-Oss

   57 implants placed at 6 months

   stage 2 surgery in 6 months

   cores at 6 & 12 months in 3 patients

   cores taken through crest
시간이 지남에 따라 분명 new bone 은 증가하나 non -grafted area의 %를 넘어서지 못한다.

Results achieved with different grafting materials

1) Sinus floor elevation using anorganic bovine bone matrix (Osteograf/N) with and without autogenous bone
Froum S et al

Graft combinations in study

<table>
<thead>
<tr>
<th>Graft material</th>
<th>% new bone</th>
<th>% Bio-Oss</th>
<th>% marrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grafted area 6 months</td>
<td>21</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Non-Grafted area 6 months</td>
<td>24</td>
<td></td>
<td>76</td>
</tr>
<tr>
<td>Grafted area 12 months</td>
<td>28</td>
<td>27</td>
<td>45</td>
</tr>
<tr>
<td>Non-Grafted area 12 months</td>
<td>31</td>
<td></td>
<td>69</td>
</tr>
</tbody>
</table>

Xenograft + DFDBA 가 Xenograft 단독사용 시 보다 더 많은 vital bone 형성이 이루어짐을 볼 수 있다

• Implant Survival

<table>
<thead>
<tr>
<th>Graft material</th>
<th>Placed</th>
<th>Failed</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteograf alone</td>
<td>25</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Osteograf + Autogenous bone</td>
<td>64</td>
<td>1</td>
<td>98.4</td>
</tr>
<tr>
<td>Osteograf + DFDBA</td>
<td>48</td>
<td>3 (Cluster)</td>
<td>93.8</td>
</tr>
<tr>
<td>Osteograf + DFDBA + Autogenous bone</td>
<td>78</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Osteograf 단독 사용시 5% vital bone range 에서도 성공을 보여주고 있는 점은 주목할만하다.

2) Clinical and histological evaluation of implant integration after sinus floor augmentation with autogenous bone, bovine HA, or a 20:80 mixture

Hallman M, Sennerby L, Lundgren S
IJOI 2002; 17:635–643

36 sinuses, vital bone contents

<table>
<thead>
<tr>
<th>Graft material</th>
<th>N</th>
<th>Range %</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% autogenous</td>
<td>37.7 ± 31.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20/80 composite</td>
<td>39.9 ± 8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% Bio-Oss</td>
<td>41.7 ± 26.6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No statistical difference

Then, How about implant survival?
36 sinuses, 111 implants, 1 year loading

<table>
<thead>
<tr>
<th></th>
<th>Overall survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% autogenous</td>
<td>82.4 %</td>
</tr>
<tr>
<td>100% Bio-Oss</td>
<td>96.0 %</td>
</tr>
<tr>
<td>20/80 composite</td>
<td>94.4 %</td>
</tr>
</tbody>
</table>

Autogenous bone이 Gold Standard 가 아닌을 보여준다.
Evidence shows mineralized bone replacement grafts can be used alone with highly predictable results.


100% Bio-Oss

Froum 1998

Evidence-based literature reviews
Wallace, Froum 2003, Del Fabbro, Testori 2004

Effect of autogenous bone, PRP

1) Effect of PRP on bone formation in Xenografts (Bio-Oss) placed in the human Maxillary sinus: A pilot study of 3 bilateral cases Froum S et al

2) Implant survival by graft material
Del Fabbro, Testori et al, IJPRD accepted

3) Particulate vs. autogenous block graft
Wallace et al, Annals Periodontol 2003; 7

<table>
<thead>
<tr>
<th>Graft type</th>
<th>Mean</th>
<th>Standard error</th>
<th>Least square mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliac block</td>
<td>80.4</td>
<td>2.96</td>
<td>83.3</td>
</tr>
<tr>
<td>particulate</td>
<td>94.8</td>
<td>1.72</td>
<td>92.3</td>
</tr>
</tbody>
</table>

*least square mean include adjustments for other variables

Sinus Graft 시의 Membrane 사용
장점: -excludes non-osteogenic connective tissue from the flap
- enhances graft containment
단점: -removes periosteum from the healing site
- inhibits vascularity

<table>
<thead>
<tr>
<th>Patient</th>
<th>Maturation time (months)</th>
<th>% Vital bone without memb.</th>
<th>% Vital bone with memb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>3.8</td>
<td>14.5</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>22</td>
<td>32.4</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>30.8</td>
<td>31</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>9.8</td>
<td>42.2</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>10</td>
<td>7.4</td>
</tr>
</tbody>
</table>

Average | 11.9 | 25.5 |
1) Effect of membrane on vital bone formation
   - Tarnow et al
   - Same graft material, same maturation time, membrane on one side only
   결과를 보면 평균적으로 membrane을 쓰는 쪽이 분명히 도움이 되고 개별적으로 보더라도 월등히 좋거나 차이가 없다. 그러므로 Sinus lift 시 membrane 사용은 이제 routine practice가 되어야 한다.

2) Intrastudy comparison of 3 randomly controlled trials
   Wallace et al, Annals Periodontol 2003: 7

3) Sinus augmentation using Bio–Oss with various membranes
   Froum et al, manuscript in preparation

<table>
<thead>
<tr>
<th>Membrane type</th>
<th># Sinuses</th>
<th>Range vital bone</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-PTFE</td>
<td>26</td>
<td>3–53</td>
<td>19.5 %</td>
</tr>
<tr>
<td>Collagen</td>
<td>43</td>
<td>3–51</td>
<td>19.0 %</td>
</tr>
<tr>
<td>No membrane</td>
<td>9</td>
<td>1–29</td>
<td>11.9 %</td>
</tr>
</tbody>
</table>

e-PTFE와 Collagen membrane 사이에 차이가 없음을 보여준다.

Survival Rate for implants

<table>
<thead>
<tr>
<th>Membrane type</th>
<th># Placed</th>
<th># Failed</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-PTFE</td>
<td>56</td>
<td>1</td>
<td>98.2 %</td>
</tr>
<tr>
<td>Collagen</td>
<td>98</td>
<td>3</td>
<td>96.9 %</td>
</tr>
<tr>
<td>Total</td>
<td>154</td>
<td>4</td>
<td>97.4 %</td>
</tr>
</tbody>
</table>

Effect of implant surfaces

1) Survival rates of implants with different surface morphologies in grafted sinuses – 6 months post loading data
   Tarnow et al, manuscript in preparation 517 patient

1461 implants loaded for a minimum of 6 months

<table>
<thead>
<tr>
<th>Surface</th>
<th>Acid-etch</th>
<th>HA</th>
<th>SLA</th>
<th>TiOBlast</th>
<th>TPS</th>
<th>Machined</th>
</tr>
</thead>
<tbody>
<tr>
<td># of implants</td>
<td>962</td>
<td>22</td>
<td>169</td>
<td>28</td>
<td>160</td>
<td>105</td>
</tr>
<tr>
<td>Survival rates</td>
<td>95.4</td>
<td>90.9</td>
<td>95.8</td>
<td>96.4</td>
<td>95.0</td>
<td>70.4</td>
</tr>
</tbody>
</table>

Average survival rates: 93.7 % (1368/1461)
   Survival rate of rough surface: 95.4 %
   Survival rate of smooth surface: 70.4 %

2) Implant survival by surface
   Del Fabbro, Testori et al IJPRD, Accepted for publication

<table>
<thead>
<tr>
<th>Surface</th>
<th># studies</th>
<th># implants</th>
<th># failures</th>
<th>% survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turned</td>
<td>19</td>
<td>2827</td>
<td>406</td>
<td>85.6</td>
</tr>
<tr>
<td>Rough</td>
<td>18</td>
<td>2939</td>
<td>115</td>
<td>96.1</td>
</tr>
</tbody>
</table>


In conclusion, Don’t place machined surface in sinus

**Interaction**

Graft material and Implant surfaces

<table>
<thead>
<tr>
<th>Graft Material</th>
<th>Mean</th>
<th>Standard</th>
<th>Least square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machined–iliac block</td>
<td>78.8</td>
<td>2.5</td>
<td>78.8</td>
</tr>
<tr>
<td>Machined–particulate</td>
<td>89.5</td>
<td>3.3</td>
<td>90.0</td>
</tr>
<tr>
<td>Rough–iliac block</td>
<td>90.9</td>
<td>6.1</td>
<td>89.5</td>
</tr>
<tr>
<td>Rough–particulate</td>
<td>94.5</td>
<td>1.2</td>
<td>94.6</td>
</tr>
</tbody>
</table>
Vital bone formation is
-time dependent
-graft material dependent
-enhanced with a barrier membrane
Implant survival is
-graft material dependent
-enhanced with a barrier membrane
-enhanced by a rough surface (가장 중요!!)
Biology Rules!!!

Aesthetics

▶ 3-dimensional placement
▶ Occlusal–gingival
▶ Facial–lingual
▶ Mesial–distal
▶ 3-dimensional integration

Occlusal–gingival level의 고려
1998 년의 concept 은 3mm from the height of soft tissue (apical to adjacent CEJ) 였다. 그러나 만약 이처럼 implant platform이 crest 에 위치하게 되면 interdental area 에서는 3mm + 4.5mm (between labial tissue and papilla) 가 되어 약 7.5 ~ 10mm 의 차이가 생기며 최 번째 thread 까지 흡수되는 biologic width 까지 고려 시 약 9mm정도의 차이가 생긴다

Facial–lingual의 고려
Gingival recession around wide vs. standard diameter implants: A
5-year longitudinal prospective study
Small P, Cho S, Tarnow D
PPAD 2001; 15:527–532
Buccal Recession
전 기간에 걸쳐 standard diameter의 recession 정도가 wide diameter implant를 사용한 경우보다 작았다.

<table>
<thead>
<tr>
<th></th>
<th>Standard diameter</th>
<th>Wide diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthesis insertion</td>
<td>0.43 mm (138)</td>
<td>1.15 mm (58)</td>
</tr>
<tr>
<td>3 month</td>
<td>0.56 mm (138)</td>
<td>1.41 mm (58)</td>
</tr>
<tr>
<td>6 month</td>
<td>0.61 mm (138)</td>
<td>1.45 mm (58)</td>
</tr>
<tr>
<td>1 year</td>
<td>0.69 mm (128)</td>
<td>1.48 mm (54)</td>
</tr>
<tr>
<td>18 month</td>
<td>0.82 mm (110)</td>
<td>1.55 mm (45)</td>
</tr>
</tbody>
</table>

Mesial–distal의 고려

1) Radiological evaluation of marginal bone loss at tooth surfaces facing single Brånemark implants
Esposito M et al

COIR 4(3): 151–157, 1993
The mean bone loss at adjacent tooth surfaces increased with increasing distance fixture–tooth for the time interval between preoperative evaluation and crown installation

2) Influence of flap design on peri-implant interproximal crestal bone loss around single tooth implants
Gomez–Roman G
IJOMI 16; 61–67, 2001
Adjacent tooth 에 약간의 tissue를 남겨두는 limited flap design이 0.5mm, wide flap 이 2mm 정도의 bone loss 를 보여주었다

3) The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla
Tarnow et al
J Periodontol 63: 995–996, 1992
Presence of papillae (n=288)
1 year F/U 에서 17 papilla 가 거의 완벽하게 자라났음을 볼 수 있으며, implant crown insertion 시 환자에게 (contact 이 제대로 있는 한) papilla growth 는 시간이 걸림을 주지시킨다!

5) Restoring the gingival contour by means of provisional resin crowns after single-implant treatment
Jemt T
Int J Perio Resto Dent 19; 21-29, 1999
2차 수술 시 Healing abutment를 채우든지, 바로 temporary crown을 제작해주든지 치는 papilla growth 에는 큰 영향을 주지 않는다.
술 후 2년 follow up 에서 soft tissue volume에 차이가 없었음

Is the 5mm rule also true for papillae between teeth and implants? Yes

6) Stability of the mucosa: Topography around single-tooth implants and adjacent tooth: 1 year result
Grunder U, IJPRD 20; 11-17, 2000
자연치와 implant 사이의 papilla존재 여부는 implant 쪽이 아니라 치아 쪽 bone level이 결정적인 요소다.
Contact point 에서 bone level 까지의 거리가 거의 9mm (max 10.5)인 경우에도 자연치 쪽이 5mm 이하인 경우 문제가 없었음.

7) clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants: A retrospective study in the Maxillary anterior region
Choquet V, Hermans M, Tarnow D, Malevez C
J Periodontol 72; 1364-1371, 2001
26 patient, 27 Brånenmark Implant
17 implant: uncovered with a standard technique
10 implants: generate papilla—like formation
52 papillae were evaluated clinically and radiographically.

Immediate implant placement and Immediate provisionalization
Immediate vs. delayed placement variables
- height of soft tissue
- thickness of soft tissue
- amount of keratinized tissue
- degree of inflammation of buccal tissue
- thickness of buccal plate of bone (가장 중요)
- are adjacent crowns being placed
- histologic vs. clinical success
- placement of graft or not?
- was flap elevated?
- was membrane placed?
- was primary closure achieved?
- was implant placed facially or palatally
- provisionalization
- fixed or removable?

1) Single tooth replacement in the aesthetic zone with immediate provisionlization; 14 consecutive case reports
Wohrle PS
PPAD 10: 1107-1114, 1998
Immediate provisionlization은 papilla를 위해서는 좋지만 midfacial tissue height 에도 도움이 되는가 하는 문제는 questionable 하다.

2) Evaluation of Ti-implants placed into simulated extraction sockets: A study in dogs
Akimoto K, Becker W
IOMI 14: 351-360, 1999
Clinically, all control and test sites healed with complete bone fill in the defect. But, histologically there's space. As the gap widened, the amount of bone-to-implant contact decreased, and the point of the highest bone-to-implant contact shifted apically.

3) Dimensions of peri-implant mucosa: An evaluation of maxillary anterior single implants in humans
Kan JYK, Rungcharaussaeng K, Kois JC
Bone-sounding measurements of anterior implant single crowns comparing thick and thin biotype

<table>
<thead>
<tr>
<th>Site</th>
<th>Thick biotype (n=28)</th>
<th>Thin biotype (n=17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI (mesial of implant)</td>
<td>6.54 ± 1.05</td>
<td>5.56 ± 1.40</td>
</tr>
<tr>
<td>F (mid facial)</td>
<td>3.79 ± 0.89</td>
<td>3.38 ± 0.91</td>
</tr>
<tr>
<td>DI (distal of implant)</td>
<td>6.14 ± 1.11</td>
<td>5.59 ± 1.31</td>
</tr>
<tr>
<td>DT (distal of tooth)</td>
<td>4.45 ± 0.57</td>
<td>3.79 ± 0.56</td>
</tr>
</tbody>
</table>

<<Ice cream Technique>>
Handle - socket
아이스크림 - over the top
extraction socket 에 bone material 삽입 후 collagen membrane사용 buccal plate missing area 에 handle 모양 삽입, 아이스크림 쪽은 bone material 을 덥고 palatal 쪽에서 2-3 suture, buccal 쪽은 suture 안 합
**Between adjacent implants**

Is the 5 mm rule also true for papillae between implants? NO

1) The effect of inter-implant distance on the height of the inter-implant bone crest

Tarnow DP, Cho SC, Wallace S


Inter-implant distance less than 3mm show increased crestal bone resorption

1) D (distance between the adjacent implant) >3mm (n=11)

X (implant shoulder to inter-implant crest peak) = 0.45mm

2) D ≤ 3 mm (n=25)

X = 1.04mm

2) The vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implants

Tarnow et al, J Periodontol 74; 1785–1788, 2003

<table>
<thead>
<tr>
<th>Height of papilla (mm)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>1.5</td>
<td>16.9</td>
<td>35.3</td>
<td>37.5</td>
<td>5.9</td>
<td>0.9</td>
<td>2.2</td>
<td>100%</td>
</tr>
</tbody>
</table>

반 이상의 case 가 3mm 이하이므로 문제

4 Maxillary incisor missing case

-2 laterals 에 implant

3-dimensional positioning

1) platform switching

: placing a “smaller” diameter abutment on a larger diameter implant seating surface

3) Scalloped implant의 사용

: Nobelbiocare의 Scalloped implant는 정확한 개념에서 출발하였으나 screw type이어서 정확히 식립하는 것이 힘들어서 성공적이지 못했다. Dr. Tarnow’s version of Scalloped implant는 Endopore와 같은 mallet을 이용한 식립을 하므로 식립 용이.

**Golden Rule**

Do all site development before implant placement into the aesthetic zone

Do one miracle at a time

Use the “KISS” principle (Keep It Simple, Stupid!!)

**Treatment Planning guidelines in the aesthetic zone**

Do all significant site development before placing implants

Place implants 2 to 3 mm apical to desired height of facial tissue

Place implants at least 1 to 1.5 mm away from adjacent teeth

Position implants palatal to the incisal edge or at the cingulum

Use ovate pontic

Use papillae saving incisions where possible

Avoid adjacent implants if possible

Overbuild the inter-implant bone before placing implants adjacent to each other
Place adjacent implants 3mm apart to preserve the crestal bone
Place a scalloped top implant (??) or platform switching