Can we improve atrophic alveolar ridge by surgically-assisted tooth movement?

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Accelerated tooth movement
Accelerated tooth movement

• Non-invasive $\rightarrow$ Not clinically significant
• Minimally-invasive $\rightarrow$ Not clinically significant enough
• Invasive $\rightarrow$ Can be available, but less than 3 months

• Well-designed prospective clinical study is needed.
Surgically-assisted orthodontics

- Ridge augmentation
- Corticotomy
- Micro-osteoperforation
- Osteogenic orthodontics
- Corticision
- Osteotomy
Surgically-assisted orthodontics

Osteotomy-assisted orthodontics
- Segmental osteotomy
- Individual tooth osteotomy
- Alveolar distraction osteogenesis

Corticotomy-facilitated orthodontics
- Block / Individual corticotomy
- Selective alveolar decortication
- Periodontally accelerated osteogenic orthodontics

Minimally-Invasive Cortical Activation
- Corticision
- Piezocision
- Piezopuncture
- Micro-osteoperforation
Surgically-facilitated orthodontics

→ Transient accelerating effect of OTM!

Goal I. Reducing treatment time

No investigation on overall treatment time
well-controlled prospective clinical study
high level of evidence

El-Angbawi et al. Cochrane Database Systematic review 2015
Alfawal et al. Prog Orthod 2016
Miles P. Australian Dent J 2017
Surgically-assisted orthodontics

Goal I. Reducing treatment time

Goal II. Overcoming anatomical limitation
Part I. Orthodontic root thrusting

ATM into atrophic alveolar ridge

Part II. Surgically-assisted TM

Part III. Biomodulation-assisted TM
Residual Ridge Resorption
Part I. OTM into atrophic alveolar ridge
OTM into atrophic ridge in Adults
OTM into atrophic alveolar ridge for prosthetic preparation?
Ridge width around the moved tooth?

→ looked increased but by the tooth width not by new bone formation.

OTM into atrophic ridge in adults

1. Impaired tooth movement
2. Dehiscence & attachment loss
3. Lateral root resorption
Orthodontic solution for atrophic ridge

Bodily movement

in case of a tooth with normal vertical periodontal support

“Orthodontic in vivo tissue engineering”

Root thrusting movement

W. Eugene Roberts. PCSO 2014
Birte Melsen. 2014
Can we improve atrophic alveolar ridge by root thrusting only?
Response of atrophic ridge to Root thrusting


with or without open-flap decortication

No intervention

Root thrusting

Group C (n=4)

Group R (n=6)

Group RD (n=6)
Can we improve atrophic ridge by Root thrusting?

Reciprocal root thrusting + open-flap decortication

- Bone density
- Bone volume
- Rate of TM
- Bone density
- Bone volume: N-S
Orthodontic approach for atrophic ridge

1. Growing patient
2. Teeth with normal marginal bone support
3. No severely constricted ridge thickness
4. Root-dominant movement

Surgical approach!
Part II. Surgically-assisted TM into atrophic ridge

Ridge augmentation

Flapless decortication

Segmental osteotomy
II-1. TM into atrophic ridge treated by Ridge augmentation
Ridge augmentation

Decortication

Bio-Oss collagen graft

Collagen membrane

2W after surgery
6M after protraction

12M after protraction
12M after protraction (14M after bone graft)
Can we improve atrophic alveolar ridge by augmented corticotomy-assisted TM?
Demineralization; therapeutic osteopenia

Osteoid transportation; as long as TM is accompanied

+ Osteoconduction

Remineralization; at the end of TM

• Bone volume
• Bone density

Healing after augmented corticotomy

“Bone matrix transportation”
Clinical efficacy for orthodontists?

1. Need high skill for flap surgery
2. Need waiting time before initiating TM
3. Risk of impaired TM & root resorption
4. Risk of graft failure (only-graft type)

II-2. TM into atrophic ridge treated by flapless decortication
Highly resistant TM
Micro-osteoperforations (MOP)
2W post-MOP

3 M post-MOP
Healing after Flapless decortication

Microdamage → Activation → Resorption → Formation → ATM

RAP

Transient Osteopenia
Less Hyalinization
Can we improve atrophic alveolar ridge by flapless decortication-TM?
Response of atrophic ridge to **flapless MOP**

*Lee JW, Lee JH, Cha JY, Kim SJ. AJODO 2017 in review*

**Group C** (n=6)  
**Group MOP** (n=6)
Can we improve atrophic ridge by Decortication-TM?

- Flapless decortication
- Rate of TM
- Bone density
- Bone volume: N-S
II–3. TM into atrophic ridge treated by Segmental osteotomy
Asymmetric ASO
Post-surgical TM into osteotomy gap

Protraction of posteriors

Retraction of anteriors

Midline correction
Can we improve osteotomy gap on the preexisting atrophic ridge with ATM?
Healing after Osteotomy / Corticotomy

Corticotomy-facilitated TM
- Transient local osteopenia around roots by RAP

Osteotomy-assisted TM
- Fracture or DO-like healing
- No paradental osteopenia
Healing-based TM into osteotomy gap

0W: Fresh wound
2W: Woven bone
12W: Non-union
Hypermaturation
Healing of osteotomy - preexisting atrophic ridge
Timing of force application affects the rate of tooth movement into surgical alveolar defects with grafts in beagles

Hyo-Won Ahn, a Joo-Young Ohe, b Sang-Hyun Lee, c Young-Guk Park, d and Su-Jung Kim a

Initiating TM at 0, 2, 12 weeks post-op.
Can we improve **Osteotomy gap** with ATM?

**Conclusion**

TM at 2W post-osteotomy

- Rate of TM
- Bone density
- Bone volume: **N-S**

Immediate TM to grafted-osteotomy
Part III. Biomodulation-assisted TM

understand
Effect of low-level laser therapy on orthodontic tooth movement into bone-grafted alveolar defects

Kyung-A Kim, Eun-Kyung Choi, Joo-Young Ohe, Hyo-Won Ahn, and Su-Jung Kim
Can we improve Osteotomy-TM with biostimulation?

TM into Lased-grafted-osteotomy

- Rate of TM
- Bone density
- Bone volume N-S
1. Optimal timing to initiate post-surgical TM depends on defect healing state: Target woven bone!

2. Biomodulation of healing state is promising to develop a novel ATM procedure with periodontal regeneration.
Healing-based TM into atrophic ridge

- Horizontal constriction
- Marginal bone support
  - Orthodontic root thrusting
  - Surgically-assisted TM
    - Flapless decortication
    - Augmented corticotomy
    - Segmental osteotomy
Can we modulate the healing period to maximize the *woven bone* state?
Gene expression profile altered by orthodontic tooth movement during healing of surgical alveolar defect

Eun-Kyung Choi, a Jae-Hyung Lee, b Seung-Hak Baek, c and Su-Jung Kim d

[Images of dental models labeled A, B, C, and D, with annotations for natural healing model and OTM-related healing model]
Microarray gene profiling

Hierarchical clustering heatmap

Color Key

Row Z-Score

Sig_Hierarchical clustering (data3)

Z-score

D-6  D-2  DT-6

D6-2  D6-1  D2-1  D2-2  DT6-1  DT6-2
8 clusters of differentially expressed genes
Verification of critical DEGs by Real time RT-PCR

A. TNFSF11

B. MMP13

C. SPP1

D. DMP1

Comparison
Biomodulation of woven bone healing

- **Accelerating formation**
  - Granulation tissue
    - SPP1
    - DMP1
  - Immature woven bone
    - CTSK
    - MMPs
    - ACP5
    - TNFSF11
  - Mature lamellar bone

- **Delaying maturation**
Further studies for tissue-regenerative ATM

Controlled TM with periodontal regeneration

ATM into alveolar defect

Accelerated tooth movement (ATM)
Thank you!