Accelerated orthodontics or accelerated liability?
Laura Aventi
Aventi, Inc.

We all know that when an orthodontic appliance is placed, the teeth are moved efficiently and would be to a quicker than usual speed movement. Some of this work is done with kinetics, and some of this work is done with matrices. In some cases, we use a combination of kinetics and matrices to achieve the desired result. In other cases, we use a combination of kinetics and matrices to achieve the desired result. In some cases, we use a combination of kinetics and matrices to achieve the desired result. In other cases, we use a combination of kinetics and matrices to achieve the desired result.

When a new patient calls the office for an initial consultation, the doctor and team members will discuss the treatment plan, including the estimated time and cost. The patient is then scheduled for an appointment to begin treatment. The first visit is usually a consultation, where the patient and doctor discuss the treatment plan and any potential risks and benefits. The patient will then return for follow-up appointments to monitor progress and adjust the treatment plan as needed.

In this issue, we will discuss the benefits and potential risks of accelerated orthodontics, including:

- Increased efficiency and shorter treatment times
- Potential for improved oral health and aesthetics
- Potential for increased quality of life

However, there are also potential risks to be aware of, including:

- Increased risk of tooth movement outside of the dental arch
- Potential for increased risk of tooth loss
- Potential for increased risk of temporomandibular joint (TMJ) dysfunction

It is important for both patients and orthodontists to be aware of these potential risks and benefits before starting treatment. By discussing these issues with the patient, the orthodontist can help ensure that the patient’s expectations are realistic and that informed consent is obtained.
1 year old cat, Corticision at distal to canine

12-24-2008
finishing at 9 mos

08-08-2008
4.8mos after corticision

06-16-2008
3mos after corticision

03-06-2009
debonding at 11 mos

Park YG, Angle Orthod 2009

Radiogram of tissue block, 29d
Corticision Group, mobile
Distinct radiolucent line (unhealed corticision gap)
The woven bone formation was found along the resorbed bone surface, tension side, 21 d, HE, X40

Surgical gap was filled with new bone. Overlying soft tissue was recovered.

While mean apposition rate of control group (group A) showed peak value on day 21 following 14 days of low value, the rate of experimental group represented earlier peak value on day 14(B). There was no remarkable difference of accumulated apposition area between group A and group C, and accumulated mean apposition area of 'Corticision' group on day 28 days was observed 3.5-fold higher than that of control group(B).
Introduction: The aim of this study was to evaluate the effect of 2 distinct magnitudes of applied force with and without corticosteroid (dexamethasone) on the rate of tooth movement and to examine the alveolar response in a rat model. Methods: A total of 44 male rats (6 weeks old) were equally divided into 4 experimental groups based on force level and surgical intervention: lightforce, light force with corticosteroid, heavy force, and heavy force with corticosteroid. The forces were delivered from the maxillary left first molar to the maxillary incisors using prefabricated 10g (light force) or 15g (heavy force) nickel-titanium springs. The corticosteroid procedure was performed as appliance placement and repeated 1 week later on the mesial aspect of the maxillary left first molars, with the right sides serving as the untreated controls. Microcomputed tomography was used to evaluate tooth movement between the maxillary first and second molars, and the alveolar response in the region of the maxillary first molar on day 14. Osteoclasts and osteoblasts were quantified, and the expression of receptor activator of nuclear factor kappa B ligand was examined. Results: Intergroup comparisons of bone volume fraction (BV/TV) and bone density were found to be significantly less on the treated sides, with the exception of BV/TV in the light force group. Intergroup comparisons evaluating magnitude of tooth movement, BV/TV, apparent density, and bone density showed no significant differences. Histologic analysis indicated that BV/TV was decreased in the light force group. No significant differences in the total numbers of osteoblasts and osteoclasts and the expression of receptor activator of nuclear factor kappa B ligand were found between the groups. Conclusions: No differences in tooth movement or alveolar response were observed with microcomputed tomography based on force level or corticosteroid procedure. A decrease in the region of the maxillary incisors treated with corticosteroid was observed, and there was a decrease in BV/TV and bone density in the treated sides, with the exception of BV/TV in the light force group. Intergroup comparisons evaluating magnitude of tooth movement, BV/TV, apparent density, and bone density showed no significant differences. Histologic analysis indicated that BV/TV was decreased in the light force group. No significant differences in the total numbers of osteoblasts and osteoclasts and the expression of receptor activator of nuclear factor kappa B ligand were found between the groups.

Evidence-based Practice (EBP)

EBP is integration of best research evidence with clinical expertise and patient values.
Accelerated treatment techniques were listed on the questionnaire for the first time. About 26% of the respondents reported some use of these methods in the previous year, with a median six cases treated. Although a number of techniques were used, the most common were AcceleDent (used routinely or occasionally by 62% of the practices performing accelerated treatment)…

Non-invasive method vs. Surgical method

- Accelerated treatment techniques were listed on the questionnaire for the first time. About 26% of the respondents reported some use of these methods in the previous year, with a median six cases treated.

- Although a number of techniques were used, the most common were AcceleDent (used routinely or occasionally by 62% of the practices performing accelerated treatment)…

Clinical trials in KHU

- Vibration
  - The effects of vibration on the rate of orthodontic tooth movement during alignment

- Photobiomodulation
  - The effects of LED PBM on the rate of orthodontic tooth movement during space closure
Accelerating tooth movement by Non-Invasive Devices

**Vibration**
- What is the vibration?
- Development of vibration studies on ATM
- Current clinical studies of vibration in progress

**Photobiomodulation**
- What is the photobiomodulation?
- Development of photobiomodulation studies on ATM
- Current clinical studies of photobiomodulation in progress

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Skeletal homeostasis and bone formation

**Bone mass is maintained under…**

Rubin, et al. 2002

- 4 cycles per day of 2,000 microstrain
- 100 cycles per day of 1,000 microstrain
- Hundreds of 1,000 cycles of <10 microstrain

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**Osteogenic potential of HFLM force**

Cyclic forces have been proven to alter physiological responses in long bones...

- Increased rate of *fracture healing*
- Increased cellular signaling to enhance *bone density*

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**Vibration & bone metabolism**

- Activates mechanoreceptors in bone cells
- Stimulates molecules that regulate OBs and OCs
- Increases the anabolic activity of bone tissue

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Frost. 1960

**Mechanostat theory**

- Increased loading: Exercise, Orthodontic Treatment
- Reduced loading: Long-term bed rest, Zero Gravity

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Rubin, et al. 2002

The extremely low level (< 10 microstrain), high frequency (20-50 Hz) mechanical strains are as effective to maintain the skeleton as the bigger strains typically associated with vigorous activity (>2,000 microstrain).
Animal studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Jour</th>
<th>Frequency (Hz)</th>
<th>Amplitude</th>
<th>Model</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhao et al.</td>
<td>2008</td>
<td>Bone</td>
<td>1.5</td>
<td>0.3</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao and colleagues</td>
<td>2009</td>
<td>Bone</td>
<td>3</td>
<td>0.2</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao et al.</td>
<td>2009</td>
<td>Bone</td>
<td>5</td>
<td>0.4</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao and colleagues</td>
<td>2009</td>
<td>Bone</td>
<td>10</td>
<td>0.6</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao et al.</td>
<td>2009</td>
<td>Bone</td>
<td>50</td>
<td>0.8</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao and colleagues</td>
<td>2009</td>
<td>Bone</td>
<td>100</td>
<td>1</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao et al.</td>
<td>2009</td>
<td>Bone</td>
<td>200</td>
<td>1.2</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
<tr>
<td>Zhao and colleagues</td>
<td>2009</td>
<td>Bone</td>
<td>500</td>
<td>1.4</td>
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<td>Improved bone formation and osteoblast proliferation</td>
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<tr>
<td>Zhao et al.</td>
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<td>1000</td>
<td>1.6</td>
<td>Rat</td>
<td>Improved bone formation and osteoblast proliferation</td>
</tr>
</tbody>
</table>

Animal studies, vibration
Increased bone metabolism w/ tooth movement

Consistent results of increased bone remodeling and accelerated tooth movement using vibration.

Development of vibration on ATM
Clinical studies

Findings from human studies
- Alignment
- Extraction space closure
- No clinically relevant root resorption
- Satisfied with treatment
- Easy to use
- Reduce pain
Study design

Inclusion criteria
1. Little’s Irregularity Index:
   - Non-extraction group: 4–7mm
   - Extraction group: > 8mm (Upper 1st premolar extraction)
2. Good oral hygiene
3. No radiographic evidence of periodontal diseases

Assessment
- Impression at every visit during alignment (every 3wks)
- Irregularity measurement: distance from contact point to adjacent tooth contact point (Sum of UR3 to UL3)

Photobiomodulation
- What is the photobiomodulation?
- Development of photobiomodulation on ATM
- Current clinical studies in progress

Vibration

Current clinical study of vibration on ATM

KHU clinical study in progress

Study design

Grouping

- Group A (n=15): Non-extraction, Home use
  (AcceleDent™, 25gram, 30Hz, 20min/day)
- Group B (n=15): Extraction, Home use
  (AcceleDent™, 25gram, 30Hz, 20min/day)
- Group C (n=15): Non-extraction, Control
  Orthodontic only and No Vibration
- Group D (n=15): Extraction, Control
  Orthodontic only and No Vibration

Result

Little Index (mm)

Mean rate: 1.43 mm/mo.
What is the Photobiomodulation?

Biostimulatory effect

Photobiomodulation

- ATP ↑
- Cell activity ↑
- Bone / PDL remodeling ↑
- Accelerate tooth movement

Biostimulatory effect of photobiomodulation with LLLT

Wound healing
- Kana JS, et al. 1991
- Markson E, et al. 1998, 1999

Anti-inflammation
- Markson E, et al. 1995
- Sahlgren C, et al. 1993

Pain reduction
- Abdulmajeed, et al. 1995
- Toftmark H, et al. 2005

Fibroblast and chondroblast proliferation
- Rodionov M, et al. 1986
- Sjodahl R, et al. 1986
- Yen BH, et al. 1992
- Schultze US, et al. 1985

Collagen synthesis
- Alonso IF, et al. 1994
- Belfort GC, et al. 1986

Nerve regeneration

Bone regeneration
- Fracture Healing, ATM

Biostimulatory effect of photobiomodulation, Hamblin 2006

600-950 nm

Cellular Photoreceptor

Wound healing
- Pain, edema
- Tissue repair, prevention of tissue death

Relief of inflammation
- Acute injuries
- Chronic diseases

Neurogenic pain
- Neurological problems
- Acupuncture

Effects of Low-Level Laser Therapy After Corticision on Tooth Movement and Parodontal Remodeling

Source: Allinger and Misch 2006. 2006

Background and Objectives: Both endogenous and exogenous light have been associated with various effects on biotissue. The objective was to develop a research model to examine the therapeutic effects of low-level laser therapy (LLLT) on biotissue.

Biostimulation: Stimulatory effect in cell culture was evidenced by increased oxygen consumption, intracellular adenosine triphosphate (ATP) production, and increased cell proliferation. The LLLT-exposed group showed significantly increased oxygen consumption compared to the control group. This study demonstrated a significant increase in ATP production and cell proliferation in the LLLT-exposed group compared to the control group.

Conclusion: The findings of this study suggest that LLLT may have potential therapeutic applications in the field of biotissue. Further research is needed to investigate the mechanisms underlying the observed effects and to determine the optimal parameters for clinical use.
What is the Photobiomodulation?

Low level laser & LED

## Low level laser & LED

<table>
<thead>
<tr>
<th>Feature</th>
<th>Laser</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength constant</td>
<td>Monochromatic</td>
<td>Nearly monochromatic</td>
</tr>
<tr>
<td>Coherence</td>
<td>Coherent</td>
<td>Incoherent</td>
</tr>
<tr>
<td>Directionality</td>
<td>High directionality</td>
<td>Low directionality</td>
</tr>
<tr>
<td>Ease of use</td>
<td>Complex</td>
<td>Easier</td>
</tr>
<tr>
<td>Cost</td>
<td>Higher cost</td>
<td>Lower cost</td>
</tr>
</tbody>
</table>
Ease of use
Complex vs Easier

Laser, Complex for use
Chair time is required,
Operator must be trained,
Time consuming.
Caution when used by layperson.

Advantage/Disadvantage
Selective site vs whole arch.
Once a week application.

Ease of use
Complex vs Easier

LED is Easy & safe
Application to a larger area of the body surface with fewer side effects
Layperson able to use easily
Area of pin point positioning may not be an issue

Low level laser & LED, Karu 2005

<table>
<thead>
<tr>
<th>Low level laser</th>
<th>LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher cost</td>
<td>Lower cost</td>
</tr>
<tr>
<td>Time consuming</td>
<td>Shorter treatment duration</td>
</tr>
<tr>
<td>Repeatability and positioning may be an issue.</td>
<td>Repeatability and positioning may not be an issue.</td>
</tr>
<tr>
<td>Chair time is required.</td>
<td>Easy to use</td>
</tr>
<tr>
<td>Operator must be trained.</td>
<td>Safe to use</td>
</tr>
<tr>
<td>Application to a pin point area</td>
<td>Fewer side effects</td>
</tr>
<tr>
<td></td>
<td>Application to a larger area of the body surface</td>
</tr>
</tbody>
</table>

Development of photobiomodulation on ATM
Molecular & cellular response to photobiomodulation

Development of photobiomodulation on ATM
Animal & Clinical studies, from LLLT to LED

Carvalho-Lobo, SR, 2014

Tooth Movement in Orthodontic Treatment
with Low Level Laser Therapy:
A Systematic Review of Human and Animal Studies

Abstract This review paper is based on a systematic literature review of studies published on the use of low level laser therapy (LLLT) in the treatment of tooth movement in orthodontics. The primary objective of this review was to evaluate the effectiveness of LLLT in accelerating orthodontic tooth movement, as well as the possible mechanisms of action involved. The review was conducted using a systematic search of the literature, with a focus on human and animal studies. The results of the review indicate that LLLT may be an effective treatment option for accelerating tooth movement in orthodontics. While further research is needed to fully understand the mechanisms of action involved, the potential benefits of LLLT include increased treatment efficiency and reduced treatment time. This review also highlights the importance of continued research in this area, as well as the need for standardization and regulation of laser therapy in orthodontics.

5 human studies (canine traction)
11 studies in rats (1st premolar traction)

4 human studies / 8 animal studies showed statistically significant changes.

It remains unclear... determining dose limits that produce desired biological effect towards reduction of the orthodontic treatment time.
Photobiomodulation, Light accelerated orthodontics
Clinical studies in progress

<table>
<thead>
<tr>
<th>Investigator / Institution</th>
<th>Status / Enrolled</th>
<th>Clinical Trials / Focus of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suzoe, USA</td>
<td></td>
<td>RCT Partial: Non-extraction. Alignment and total T1 time. Root integrity &amp; Fasal evaluation. Sham Controls. (CTB) Adolescent.</td>
</tr>
<tr>
<td>European-University College</td>
<td></td>
<td>Case series. Total T1 time: Adolescents and Adults. (Fixed brackets and mechanics).</td>
</tr>
<tr>
<td>Dubai, UAE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC Poomong-Saithong</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maharat Otto. Bankok, Thailand</td>
<td></td>
<td>Case series. Total T1 time: Adolescents and Adults. (Fixed brackets and mechanics).</td>
</tr>
<tr>
<td>TSU Tim Shaughnessy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suzoe, USA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUNG Young-Guk Park</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kyung-Hun S, Korea</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Photobiomodulation
Study agenda. Intra-oral photobiomodulation for tooth alignment

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>Difference</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment Rates</td>
<td>Control</td>
<td>10</td>
<td>0.44</td>
<td>0.2</td>
<td>0.19</td>
<td>0.83</td>
<td>186.3%</td>
<td>0.0002</td>
</tr>
<tr>
<td>Days to Alignment</td>
<td>Control</td>
<td>10</td>
<td>1.27</td>
<td>0.53</td>
<td>0.24</td>
<td>2.06</td>
<td>53.6%</td>
<td>0.0004</td>
</tr>
<tr>
<td>Starting L</td>
<td>Control</td>
<td>10</td>
<td>5.77</td>
<td>1.57</td>
<td>3.70</td>
<td>8.80</td>
<td>26.0%</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

✓ OrthoPulse™treated arches exhibit significantly faster alignment rates (186% faster), and reduces days to alignment by over 50% when compared to conventional methods. (Shaughnessy, et al. [submitted for publication])

- Experimental group: (n=30)
  - Group I (n=15) — application 3mm
  - Group II (n=15) — application 6mm
- Control group (group II, n=15)
- En masse retraction
- 19K25 SS
- Orthopulse™ (850nm, 60mW/cm²)
- Tooth movement rate

Current clinical studies of PBM on ATM
Clinical study at KHU, Seoul

Study objectives

Evaluate the effect of PBM by intraoral LED device(OrthoPulse™, Biolux, Canada) on the rate of tooth movement.

The specific aims of the study are:

- To verify the efficacy of PBM on the rate of en-masse retraction of the 6 anterior teeth in extraction cases.
- To establish the optimal clinical protocol of PBM by the intraoral LED device for accelerating tooth movement.
**Study sample**

Inclusion criteria
1. Skeletal, dental Class I with bialveolar protrusion
2. Age over 12 YO with permanent dentition, no gender discrimination
3. Upper first bicusp extraction
4. Mmaximum to absolute anchorage
No radiographic evidence of bone loss and/or periodontal conditions

**Study design, PBM; OrthoPulse™, 60mW/Cm²**

PBM; OrthoPulse™, 60mW/Cm²
- Group I (n=15): Home use of PBM Group
  Orthodontic force and Application of PBM for 3 min/day
- Group II (n=15): Home use of PBM Group
  Orthodontic force and Application of PBM for 5 min/day
- Group III (n=15): Control Group, Orthodontic force only

**Measurement**

Taking study model at every visit during space closure, and measure the amount of TM

Lateral headfilms before and after space closure, and measure the amount incisor movement.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>Mean rate : 1.15 mm/mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement distance (mm)</td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>4th</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>
Conclusion

Light-accelerated orthodontics shows promise in producing noninvasive stimulation of the dentoalveolar complex with cytochrome oxidase C mediated ATP production in the mitochondrial cells.

Cytochrome oxidase C mediated ATP production is upregulated 2-fold by infrared light. During the tooth movement, higher ATP availability helps cells turnover more efficiently, leading to an increased remodeling process and accelerated tooth movement.

Photobiomodulation, as an alternative treatment option to surgical approaches for accelerated tooth movement.

Guidelines
- Intensity
- Duration
- Dose
- Frequency
- Interaction with other treatment modality

Thank You…!