Part 1: Benefits and Risks of Orthodontic Treatment
Part 2: Methods for Acceleration of Orthodontics Tooth Movement

Before making the decision to undergo any orthodontic treatment and before starting the treatment, an analysis of risks versus benefits must be clarified and negotiated between the orthodontist and the patient and/or his (her) parents during treatment planning stage.

What are the expected benefits of orthodontic treatment?

There are 3 main proposed benefits of orthodontic treatment (Figure 1)

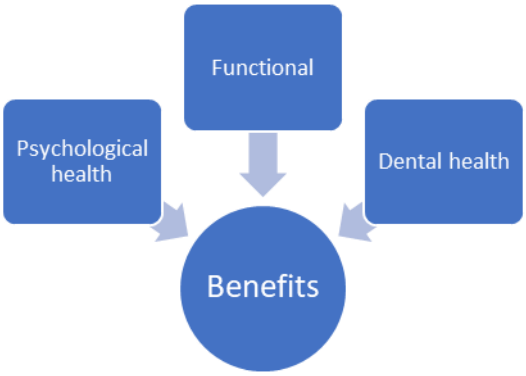

Figure 1: Benefits proposed from orthosdontic treatment

I. Psychological benefits

Improving the smile may enhance patient`s self-esteem and social interaction. This is because malocclusion affects the smile, which is the main component of attractive facial appearance, some patients with unesthetic smile may undergo teasing and bullying mainly during school age.

However, not all subjects have the same psychological response to the same degree of malocclusion. Therefore, the predicted benefit of psychological health from orthodontic treatment may be minimum if a given dental irregularity was not affecting the patient`s self-esteem. Therefore, orthodontic treatment aims to render the patient happier after treatment than before.

II. Dental Health Benefits

1. Reduction in susceptibility of traumatic anterior teeth injury

Prominent anterior teeth due to increased overjet and lip incompetence increases the risk of upper incisors injury mainly during play or accident fall (Figure 2). The more the incisors are prominent the more the risk of trauma, as shown in the table below.

How increased OJ correlates to incisor trauma?

Table 1: The correlation between incisor trauma to increased overjet.

Overjet (mm)	Prevalence of incisor injury (%)
5	22
> 9	44

Figure 2: A female patient with increased OJ was exposed to an external incisor trauma and loss of tooth vitality.

2. Reduction in complication associated with traumatic deep bite

Deep bite may cause tooth wear of upper and lower incisors and may aggravate periodontal destruction of the palatal gingiva and labial gingiva of the upper and lower incisors (Figure 3).

Figure 3: traumatic bite is the tauma of palatal and labial gingiva of upper and lower incisors due to the deep bite of opposing teeth.

What is traumatic bite?

3. Reduction in caries and improvement of periodontal health

Although adequate evidence is still not available, crowded teeth may often initiate food stagnation, dental caries, and poor periodontal condition which may develop unless patient maintains good oral hygiene by a suitable brushing technique (Figure 4).

Figure 4: Crowding of central incisor may initiate plaque accumulation and dental caries.

Does malocclusion lead to dental caries or periodontal disease?

4. Reduction in the risk associated with impacted teeth

The impacted teeth may cause resorption of adjacent teeth or may develop cystic lesions.

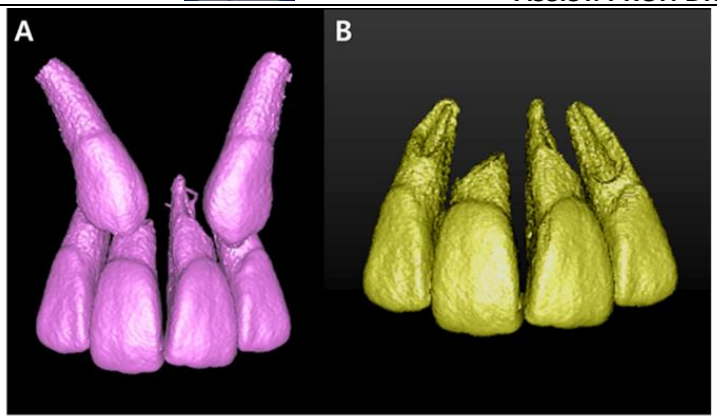

Figure 5: 3D simulation representing the aspects of root resorption by impacted teeth

How impacted canine may affect the roots of adjacent teeth?

5. Reduction in the risk of premature contact and mandibular displacement

Posterior crossbite associated with mandibular displacement may predispose a TMJ dysfunction. While anterior crossbite may lead to tooth wear and poor periodontal condition of anterior teeth (Figure 6).

Figure 6: Posterior and anterior cross bite

III. Functional benefits

The masticatory efficiency may be improved by increasing the ability to incise and chew the food particularly for patients with open bite and sever class III (Figure 7).

However, improvement of other functions such as speech and TMJ condition have no or very little evidence.

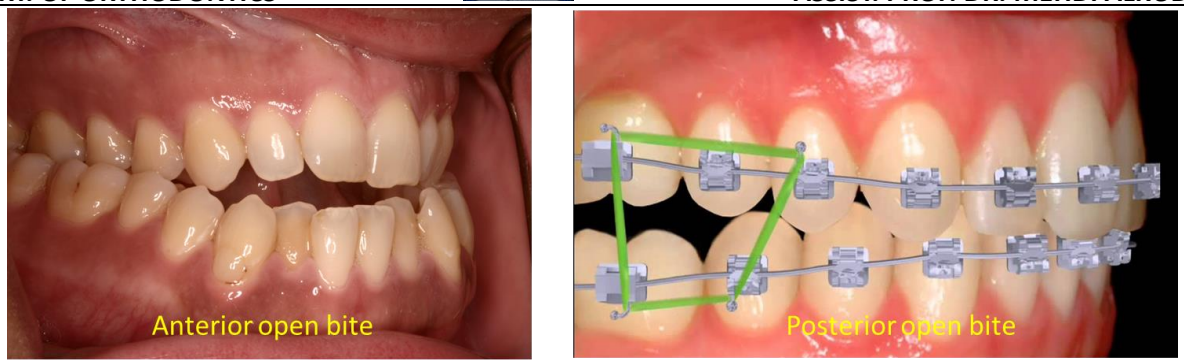

Figure 7: Anterior and posterior open bite

The risks of orthodontic treatment

- Intra oral risks
- Extra oral risks
- General risks

I. Intraoral risks (Figure 8)

Figure 8: The expected intraoral risks of orthodontic treatment

- **Decalcification**

Decalcification is the most frequent complication occurring following the bonding of bracket and adapting the arch wire in the fixed orthodontic appliance. This is due to plaque accumulation around the bonding material and underneath the arch wire. Decalcification may be present as white or brown areas or cavitation (Figure 9). Decalcification usually affects the patient`s esthetic and it can be prevented by rigorous oral hygiene control, dietary advice in addition to the use of topical fluoride supplements.

Figure 9: Post orthodontic enamel decalcification

- **Root resorption**

The majority of fixed appliance orthodontic patients may have 1-2mm of root resorption over long-term treatment (Figure 10). This may be caused as a consequence of high orthodontic forces that exceed the capillary blood pressure leading to necrosis. Multinucleated cementoclasts/odontoclasts and giant cells work to remove the necrotic cementum and dentine. Root resorption may be proportional to duration of treatment, distance of tooth movement and type/direction of force.

Figure 10: Orthodontically induced apical root resorption.

- **Gingivitis and gingival hyperplasia**

Patients treated with long-term fixed appliances may develop gingivitis if not optimize their oral hygiene (Figure 11). Therefore, orthodontic treatment should not be undertaken for patients with uncontrolled periodontal diseases.

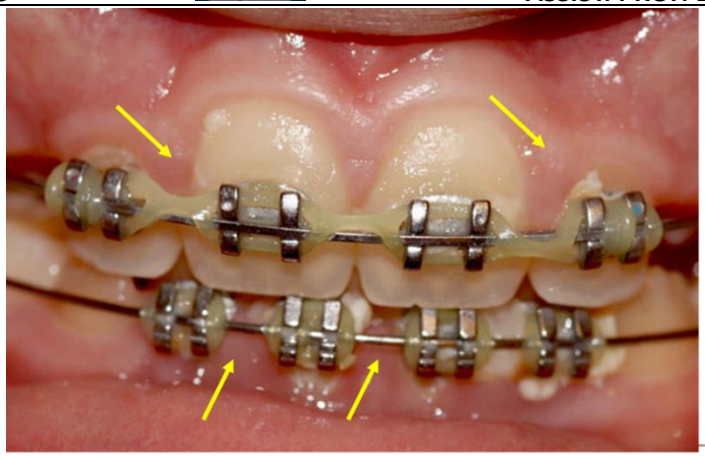

Figure 11: Gingival hyperplasia associated with orthodontic treatment by fixed appliance

- ## Loss of tooth vitality

Tooth exposed to previous trauma may undergo loss of tooth vitality due to degenerative changes within the pulp that reduce the ability to react physiologically with the orthodontic tooth movement.

Heavy orthodontic force with larger tooth movement lead to disruption of apical blood vessels and loss of vitality. Movement of root apex out of alveolar cortex would sever the apical blood vessels and cause loss of vitality (Figure 12).

Figure 12: Loss of pulpal vitality of lateral incisor during orthodontic treatment indicated root canal therapy.

II. Extra-oral risks of orthodontics

- Flattening of the face caused by extraction of upper premolar and over-retraction of the incisors which may worsen the facial profile mainly in patients with obtuse nasolabial angle (Figure 13).
- Conversely, excessive proclination of the incisor teeth in association with arch expansion can result in a poor facial appearance.

Figure 13: Obtuse nasolabial angle

- TMJ disorders (TMDs) including masticatory muscle pain, internal derangement of the TMJ disc, and degenerative joint diseases may occur as separate problems or can be in a combination with each other. TMDs may be related to orthodontic treatment although **more evidence of cause and effect** is still required.

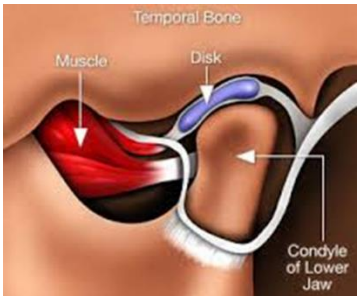

Figure 14: Normal left temporomandibular joint.

- Ocular injury and facial laceration were reported due to trauma from facebow component of headgear (Figure 15) result from accidental removal by pulling out by another child or detaching of inner bow of the headgear from the molar bands at night. Therefore, headgear with safety device is preferable in use.

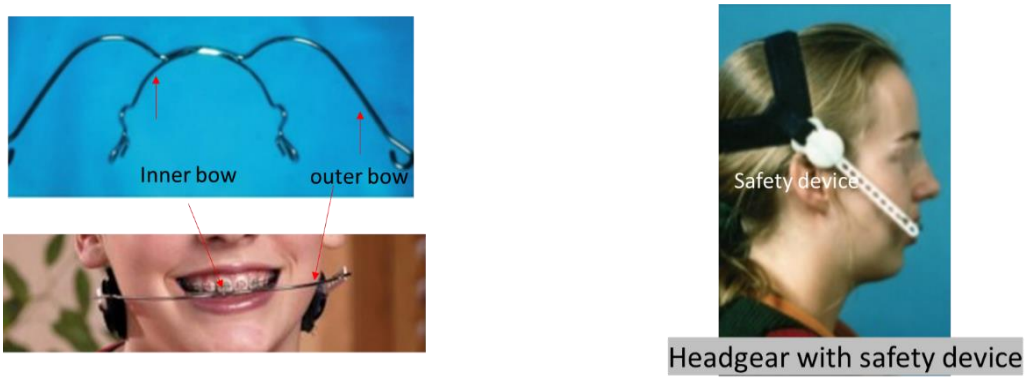

Figure 15: Headgear components

III. Generalized risks of orthodontic treatment

- **Allergic reaction** may result from direct contact of metal appliance or gloves in patients sensitive to nickel or latex.

- **Pain** is commonly arisen in patient during orthodontic treatment. Pain is either from physiologic inflammatory reactions associated with tooth movement (which should not last more than 3 days post activation visit) or possibly due to ulceration of a traumatic appliance component (Figure 16).

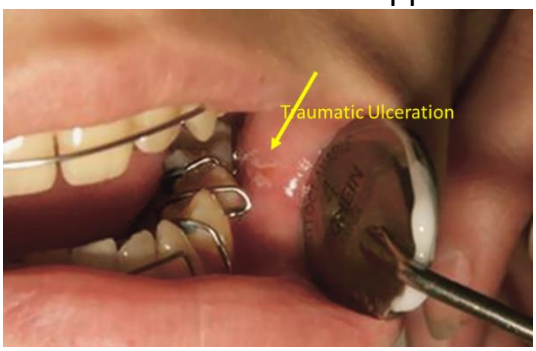

Figure 16: Ulceration of buccal mucosal lining due to orthodontic appliance trauma

- **Inadequate patient satisfaction** following the treatment due to poor addressing of the patient`s chief concern from the beginning of the treatment.
- **Relapse:** a high potential relapse after finishing the treatment in some cases such as rotated teeth, lower incisor crowding and generalized spacing. Therefore, the necessity for long term retention should be discussed with patient during treatment planning.

Part 2: Acceleration of tooth movement in orthodontics

Methods of orthodontic tooth acceleration

Methods used to increase the rate of orthodontic tooth movement can be broadly studied under the following categories:

I. Drugs.
II. Surgical Methods.
III. Physical stimulation methods.

I. DRUGS

Various drugs have been used in orthodontics since long time to increase the rate of tooth movement and have achieved successful results. These include vitamin D,

prostaglandin, interleukins, parathyroid hormone, relaxin hormone (pregnancy hormone) …etc. Some of drugs are applied locally by direct injection into PDL at the area of desired tooth movement. However, all of these drugs have some adverse effects. Todays, no drug exists that can safely accelerate orthodontic tooth movement.

II. Surgical Methods

The various surgical methods available are:

1. **Corticotomy and accelerated osteogenic orthodontics (AOO):** it is based on an idea that making cuts between teeth could produce a faster tooth movement.

Technique of corticotomy/AOO

After elevation of full thickness mucoperiosteal flaps, vertical cuts are made facially and lingually between the teeth. Bone graft material then used to augment the thickness of bone and prevent periodontal defects. Orthodontic appliance (which should be placed before surgery) is then activated to generate enough force to bring the teeth into alignment and then teeth are fixed for 6 weeks. An immediate alignment can be noticed within only minutes or hours not days or weeks.

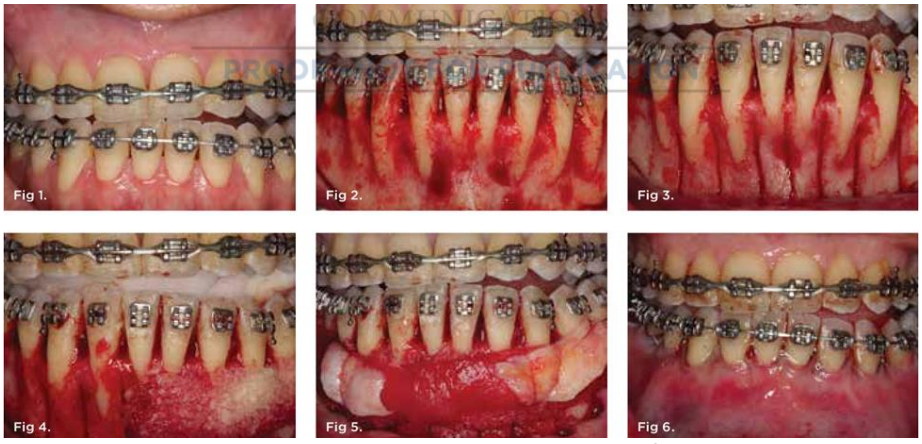

Figure 17: Technique of corticotomy/AOO

However, this technique is not widely used because of some disadvantages:

a. High morbidity and inconvenience such as pain, swelling, chances of infection, avascular necrosis may be considered.

b. Invasiveness and loss of height of alveolar bone may occur if bone graft was not used.

c. Chances of damage to adjacent vital structures such as mental nerve.

d. Low acceptance by the patient because of unsightly facial bruising and unfavourable appearance of gingiva after extensive flap

2. Piezocision (modified corticotomy)

This technique was introduced in 2009 by Dibart, a periodontist at University of Boston. Gingival incisions only on facial side between crowded teeth (or teeth to be accelerated) are made and injury to the bone at that area is performed using a vibrating piezoelectric Knife to make tunnels which are filled with bone graft.
No suturing is required, except for the areas, where the graft material needs to be stabilized. Patient is placed on an antibiotic, mouthwash regimen.

Advantages of piezocision

a. Minimally invasive.

b. higher patient acceptance.

Disadvantages: Risk of root damage, as incisions and corticotomies are “blindly” done.

3. Micro-Osteoperforations (MOP):

A third surgical method to accelerate tooth movement is based on microperforation which, unlike the previous methods, can be made by orthodontist rather than periodontal surgeon.

Technique

Multiple perforations are made using special screws like those used for skeletal anchorage which are placed through the gingiva into interproximal alveolar bone and then removed (Figure 18). Three such perforations in each interproximal area are enough to generate a regional acceleration of bone remodelling, and thereby produce faster tooth movement.

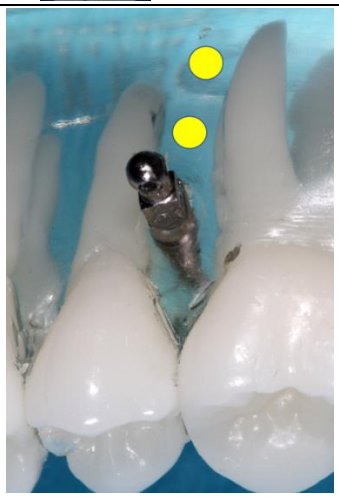

Figure 18: Micro-Osteoperforations technique for acceleration of orthodontic tooth movement

III. Physical Stimulation:

Non-invasive methods have been introduced to accelerated tooth movement since the beginning of 21st century in order to overcome the invasive effects of surgical methods. These modalities include lasers, vibration of teeth, direct electric current and application of light to alveolar process.

1. Laser

Several research studies have shown that application of low level laser therapy (LLLT) increase osteoblastic and osteoclastic activity, hence accelerate orthodontic tooth movement significantly (Figure 19). However, variations in frequency of application of laser, intensity, and method of force application on the tooth may affect the tooth movement.

Figure 19: Use of laser as a physical stimulant for acceleration of orthodontic tooth movement

2. Vibration

AcceleDent vibratory system (Figure 20) made by American company to induce piezoelectric current with vibration applied through mouthpiece that contacts the teeth for about 20 minutes per day. This may stimulate cell differentiation and maturation and then bone remodelling and tooth movement occurs more quickly. Various case studies using this device have shown the treatment times to be reduced by up to 30- 40%.

Figure 20: AcceleDent vibratory system

3. Tissue-Penetrating Light

Biolux, a Canadian company, introduced in 2010 a device which provides light with an 800- to 850-nanometer wavelength (just above the visible spectrum) (Figure 21). Light in this spectrum does penetrate soft tissue and theoretically "infuses light energy directly into the bone tissue" and to increase the rate of bone remodelling and tooth movement.

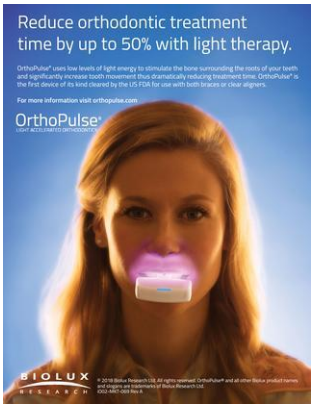

Figure 21: Use of tissue penetrating light as a physical stimulant for acceleration of orthodontic tooth movement.

4. Therapeutic Ultrasound

SmileSonica Aveo, a Canadian company, marketed a low-intensity therapeutic ultrasound device which increases blood flow in treated areas. The theory is that increased blood flow in the PDL would increase the rate of bone remodelling and tooth movement and also could decrease root resorption.

Figure 22: Use of Ultrasounds as a physical stimulant for acceleration of orthodontic tooth movement