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รายงานผู้ป่วย
Case Report

การรักษาทางทันตกรรมจัดฟันในผู้ป่วยอะมีโลเจนเนซิส อิมเพอเฟคตา: ชนิดไฮโปพลาสติก 2 ราย

ณัฐพล ตั้งจิตร* สุวรรณี ลักนะพรลาภ* ชวลิต สุจริตวิริยะกุล**

บทคัดย่อ

อะมีโลเจนเนซิส อิมเพอเฟคตา เป็นความผิดปกติที่พบได้ยาก โดยมีความผิดปกติของการสร้างผิวเคลือบฟัน หรือชั้นภายนอกของตัวฟัน ความผิดปกตินี้เป็นกลุ่มหนึ่งของสภาวะที่ถ่ายทอดได้ทางพันธุกรรมซึ่งสามารถแบ่งเป็น 4 ชนิดใหญ่ๆ ได้ดังนี้ 1. แบบไฮโปพลาสติก 2. แบบไฮโปแคลซิไฟด์ 3. แบบไฮโปแมททูเลชั่น 4. แบบไฮโปแมททูเลชั่น-ไฮโปเพลเซียร่วมกับทอโรดอนทิซึม การรักษาทางทันตกรรมจัดฟันในผู้ป่วยอะมีโลเจนเนซิส อิมเพอเฟคตา สามารถสร้างปัญหาได้เนื่องจากคุณภาพและปริมาณของผิวเคลือบฟันที่ผิดปกติ บทความนี้ รายงานถึงผู้ป่วยอะมีโลเจนเนซิส อิมเพอเฟคตา 2 ราย: ชนิดไฮโปพลาสติกแบบผิวเรียบและแบบจุดที่มารับการรักษาทางทันตกรรมจัดฟัน เนื่องจากผู้ป่วยทั้งสองรายเป็นชนิดไฮโปพลาสติก เคลือบฟันจะมีการพอกพูนของแคลเซียมเป็นปกติแต่บางกว่า ดังนั้น การเตรียมผิวฟันในผู้ป่วยประเภทนี้ก่อนการติดเครื่องมือทางทันตกรรมจัดฟันแบบติดแน่น รวมทั้งการถอดเครื่องมือสามารถทำได้ตามปกติ ไม่ปรากฏการหลุดบ่อยของเครื่องมือจัดฟันหรือความเสียหายจากผิวเคลือบฟันตลอดระยะเวลาในการจัดฟัน ทั้งสองรายประสบความสำเร็จในการรักษาทางทันตกรรมจัดฟันแบบปกติทั่วไป อย่างไรก็ตามการจัดการจำเป็นต้องมีการประสานงานอย่างใกล้ชิดระหว่างสหสาขาวิชาชีพ

คำสำคัญ: อะมีโลเจนเนซิส อิมเพอเฟคตา, ไฮโปพลาสติก, สหสาขาวิชาชีพ, ทันตกรรมจัดฟัน

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Orthodontic Treatment of Amelogenesis Imperfecta Patients: Two Cases of Hypoplastic Type

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Abstract

Amelogenesis imperfecta (AI) is a rare inherited disorder characterized by abnormal formation of the enamel or external layer of the crown of teeth. This anomality is a group of hereditary conditions that can be divided into four major types: hypoplastic AI, hypocalcified AI, hypomaturation AI and hypomaturation-hypoplastic AI with taurodontism. Orthodontic treatment in a patient with amelogenesis imperfecta could be problematic due to quality and quantity of enamel surface. This article presented 2 cases: smooth and pitted hypoplastic types of AI undergoing orthodontic treatment. Because this type of AI showed normal calcification with thin enamel, the preparation of tooth surface before bonding fixed appliances and management in removing appliance were performed conventionally. Neither the multiple bond failure nor the enamel damage had been presented throughout the treatment. These two cases were successfully treated with conventional orthodontic appliances. However, the management required an interdisciplinary approach.

Keywords: Amelogenesis imperfecta, Hypoplastic, Interdisciplinary, Orthodontics

Introduction

Amelogenesis imperfecta (AI) is a complicated group of conditions that demonstrate developmental alterations in the structure of the enamel. This condition causes teeth, in many levels, to be unusually small, discolored, pitted or grooved, and prone to rapid wear and breakage. Other dental abnormalities are also possible. Enamel formation or “amelogenesis” is under genetic control that AI is defected in the genes encoding enamel resulted in inheritable malformations of enamel by mutation and altered expression at some genes.[1-3] In fact, AI is not associated with defects in other parts of the body or other health problems.[4]

Etiology

Dental enamel is a highly mineralized tissue with over 95% of its volume occupied by large, highly organized, hydroxyapatite crystals. The formation of this highly organization occurs in ameloblasts through the interaction of a number of organic matrix molecules including several genes such as enamelin (ENAM), amelogenin (AMELX), ameloblastin (AMBN), tuftelin (TUFT), amelotin, dentine sialophosphoprotein (DSPP), enzymes such as kallikrein4 (KLK4), and matrix metalloproteinase 20 (MMP20). The ENAM, AMELX, and MMP20 genes provide instructions for manufacturing proteins that are essential for normal tooth development.[4-8] Most of these proteins are involved in the formation of enamel which is the hard, calcium-rich material that forms the protective outer layer of each tooth. The ENAM gene represents approximately 1% to 5% of enamel matrix, and mutations of the ENAM gene have been correlated with some autosomal dominant and recessive patterns of hypoplastic amelogenesis imperfecta, ranging from minor pitting to diffuse generalized thin enamel.[6] The MMP-20 gene codes for a proteinase named enamelysin; mutation of this gene has been reported to associate with the autosomal recessive pigmented hypomaturation variant of amelogenesis imperfecta.[4,8] The mutation of protease KLK4 has been also reported to be involved with some forms of hypomaturation amelogenesis imperfecta. Both enamelysin and kallikrein 4 are thought necessary for the removal of enamel matrix proteins during the maturation stage of enamel development.[4,10] Another strong report is the AMBN gene that codes for the protein ameloblastin, which constituted about 5% of enamel matrix. Although, it is not proven to be associated with amelogenesis imperfecta, this gene locus is strong candidate for some of the autosomal dominant patterns.[7,10] The distal-less homeobox 3 (DLX3) gene is in a group of genes that code for a number of proteins that are critical for craniofacial, tooth, hair, brain, and neural development; mutation of this gene has been associated with the hypoplastic-hypomaturation variants of amelogenesis imperfecta with taurodontism.[9-10] Recently, FAM83H gene (Family With Sequence Similarity 83, Member H) is believed to be involved in the formation of enamel, although the function of the protein produced from this gene is unknown.[11-12]

Classification

Amelogenesis imperfecta varies in clinical appearance that depended on the pattern of inheritance, the mutation involved, expression of matrix proteins and biochemical changes associated with the mutation. Many classifications of AI have evolved since the original classification of “hypoplastic” and “hypocalcified” types was established in 1945.[1,13-14] Until now, the multiplicity of classification systems which based primarily or exclusively on phenotype can be confusing, and it is not always possible to cross-reference between the various subtypes used, or to know which classification system might have been applied to a particular case.[13] It is urged on researchers to classify AI conditions by genome and by subsequent biochemistry for ultimately usefulness.[14] Because many studies have been reported that pattern of inheritance, abnormal phenotypes and molecular disorders, biochemical analysis of the enamel, etc., should be taken into account, consequently the number of AI subtypes mentioned in the majority of the reports are at least 10 to 15 types.[13-15] The widely accepted classifications developed are mostly relied on the phenotype and pedigree (i.e., clinical appearance and apparent pattern of inheritance; Table 1). However base on the clinical and radiographic basis alone, the characteristics of AI can be divided into 4 major types: 1) hypoplasia appearance (enamel is thin and stained with smooth or pitted surface, but normally calcified), 2) hypomaturation appearance (enamel is of normal thickness, but of reduced hardness or harder than the hypocalcified form and its color varies from yellow/brown to red/brown), 3) hypocalcified appearance (soft enamel that can be removed without difficulty), and 4) Hypomaturation-hypoplasia with taurodontism (Table 1).[15-16] Other clinical features of AI that may

Type I	Hypoplastic	
		IA - Pitted autosomal dominant
		IB - Local autosomal dominant
		IC - Local autosomal recessive
		ID - Smooth autosomal dominant
		IE - Smooth X-linked dominant
		IF - Rough autosomal dominant
		IG - Enamel agenesis, autosomal recessive
Type II	Hypomaturation	
		IIA - Hypomaturation, pigmented autosomal recessive
		IIB – Hypomaturation, pigmented X-linked recessive
		IIC - Snow-capped teeth, X-linked
		IID – Snow-capped teeth, autosomal dominant?
Type III	Hypocalcified	
		IIIA – Autosomal dominant
		IIIB – Autosomal recessive
Type IV	Hypomaturation – hypoplastic with taurodontism	
		IVA – Autosomal dominant
		IVB - Autosomal recessive

Table 1 Classification of Amelogenesis Imperfecta (AI) proposed by Witkop (1988)

be found are: delay in dental eruption, microdontia, deviant crown and morphology, root resorption, short roots, enlarge pulp chamber, pulp stones, dens in dente, and tooth agenesis.(15)

Orthodontic Management in AI

AI management is often complex and takes a significant amount of time especially in childhood to early adulthood.(16) Because clinical manifestations of AI vary according to subtype and its severity(15,17), the orthodontic treatment hence requires an interdisciplinary approach.(18) For patients with amelogenesis imperfecta teeth, enamel surface is usually difficult to bond with brackets, and also it creates the risk to damage the enamel when removing appliance.(18,21) Moreover, the weakening in enamel surface of AI has the effect of bond strengths which are usually lower than that of normal enamel surface in conventionally bonded (acid-etched)(19). This leads to multiple bond failures during treatment, and it needs to step back to rebond these teeth consequently increasing orthodontic treatment duration. The malformation in enamel surface is another factor to cause an inaccuracy in bracket position especially in pre-adjusted appliance prescription. Thus the final positions of the teeth are essentially adjusted by second and third order bends of orthodontic mechanic. Many AI cases have been treated successfully with conventional acid etch bonding methods, such as the hypoplastic type of AI. Other types that have problems of bond failures or difficulty of bracket placement are suggested to use traditional banded appliance instead of bonded bracket. Moreover, glass ionomer cement – based adhesives are recommended to improve appliance retention because it is less dependent on microtag formation, and also help in the reduction of further enamel demineralization. Preformed stainless steel crowns with welded tubes or brackets are another choice to prevent further decrease in vertical height and also sustain the bite to aid in placing final restorations after orthodontic treatment.

Debonding of the brackets can also cause fractures to the fragile enamel, and must therefore be performed with caution. The use of debonding pliers to apply a shear or tensile force according to the manufacturer's instructions is still accepted. However, pliers with narrow blades created sufficient debonding strength and led to reduced force levels on the enamel surface are recommended.[20] The management of more complex cases with severe malocclusion requires team interdisciplinary approach. This report describes two cases of patients with hypoplastic type of AI and orthodontic management.

Report of Two Cases

Case 1. A 23-year-old male was referred to the orthodontic clinic, Faculty of Dentistry, Mahidol University for orthodontic treatment. No remarkable findings were identified in his medical record including no evidence of systemic disease, nutritional deficiency, or drug treatments that may have affected dentition structure during development. His chief compliant was spacing of maxillary and mandibular teeth. From intraoral examination, this patient presented with generalized tooth discoloration, generalize spacing in upper and lower dentition, loss of mandibular right first molar, dental caries exposed pulp of mandibular left first molar, mesial tipping of mandibular left and right molars. Posterior teeth were yellow in color, but the enamel was hard (Figure 1). The panoramic

Figure 1 Case 1, pretreatment facial and intraoral photographs

radiograph showed the absence of maxillary third molars except impacted mandibular left third molar. Mandibular left first molar showed caries exposed pulp with rarified area at the apex (Figure 2). From lateral cephalometric measurements, this patient presented with skeletal type I tendency III (ANB = 0.5°), prognathic mandible (SNB = 86.5°), and with open configuration (MP-PP = 27°). Upper incisors were proclined (U1-NA = 38.5°) and lower incisors were in normal inclination (L1-NB = 30°, Figure 3). This patient was diagnosed as

Figure 2 Case 1, pretreatment panoramic radiograph

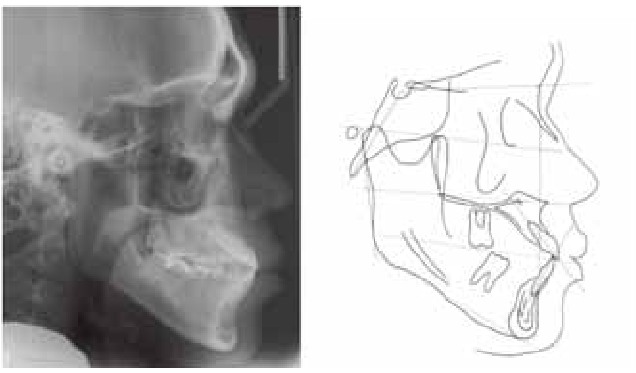

Figure 3 Case 1, pretreatment cephalometric radiograph and tracing

the skeletal type I tendency III, Angle's classification III malocclusion with spacing and hypoplastic type of amelogenesis imperfecta.

Treatment Plan

This patient was planned with non-extraction treatment except for impacted lower left third molar. Mandibular left first molar was referred for root canal treatment. The treatment objectives were to close all spaces, to correct dental asymmetries, including the correction of malocclusion to the ideal functional molar occlusion with Class I canines. Bonding procedure in this case was not differed from regular bonding. Mandibular molar teeth were planned for uprighting and distalization by orthodontic miniscrews to reinforce the anchorage at the retromolar area.

Treatment

Standard 0.022" x 0.028" edgewise brackets with Roth prescription were placed in both arches included molar teeth. In the lower arch, leveling and alignment phases were accomplished in the anterior segment and premolar area. After that, the miniscrews were inserted at the left and right anterior borders of the ramus of mandible. Sectional archwires were connected to mandibular molar teeth, and elastomeric chains were used from miniscrews to upright and distalize mandibular left first molar and right second molar (Figure 4). When mandibular molars were upright, a continuous archwire was placed for finishing phase (Figure 5). During treatment, some brackets were dislodgement due to other factors such as chewing on hard food, not enamel surfaces of AI themselves.

Figure 4 Panoramic radiograph of case 1 after uprighting lower molar teeth with miniscrews (show only left miniscrew at the retromolar area)

Treatment Results

The patient's profile was remained straight, and well-aligned arches were obtained after orthodontic treatment (Figure 6). All spaces in both dental arches were closed. Molar relationships were super Class I due to tooth-size discrepancy, however canine Class I relationships were obtained with good interdigitation. Posttreatment panoramic radiograph

Figure 5 Treatment progress of case 1
treated with fixed appliance and conventional bonding systems (acid-etch)

Figure 6 Case 1, posttreatment facial and
intraoral photographs

showed mandibular molars were upright and no root resorption or periodontal bone loss (Figure 7). The lateral cephalometric analysis and superimpositions

Figure 7 Case1, posttreatment panoramic radiograph

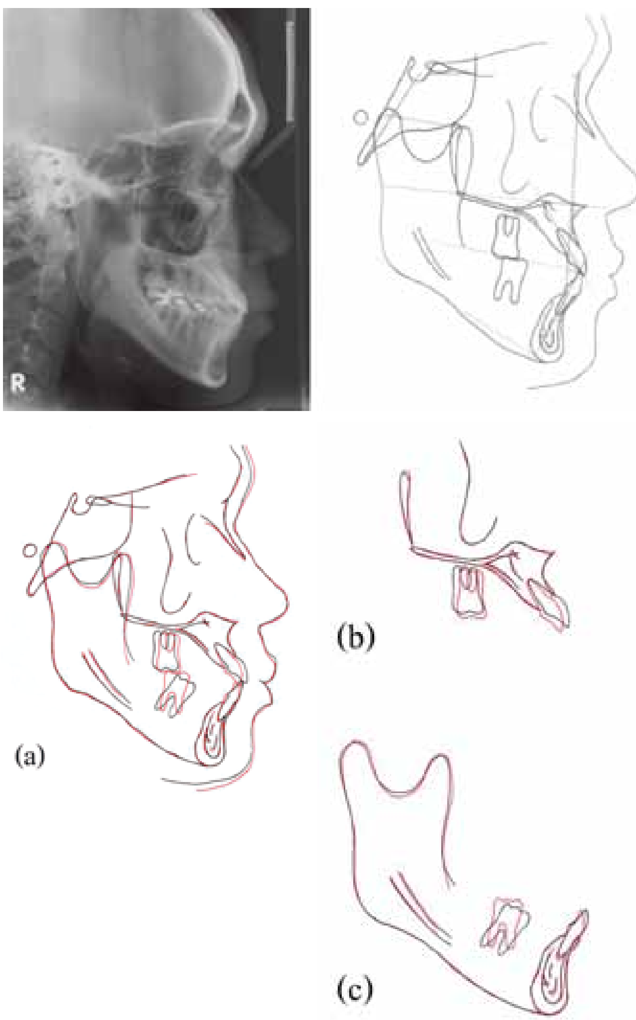

Figure 8 Case 1, posttreatment cephalometric radiograph, tracing, and superimposition; (a) Cranial base, (b) Maxilla, (c) Mandible (black = pretreatment; red = posttreatment)

after treatment showed the patient's skeletal relationship maintained as a skeletal type I (ANB = 1°, AO-BO = -0.5 mm; Figure 8, Table 2). Maxillary and mandibular incisors were in more normal inclination (U1-NA = 31°, L1-NB = 24°). Tooth surface of affected AI teeth were still normal hardness and smooth without tooth sensitivity.

Case 2: A boy, aged 12.6 years, and his parents presented to the orthodontic clinic, Faculty of Dentistry, Mahidol University with the chief complaints of dental crowding and discolored teeth. This patient was in a good physical health. However, the family history revealed that there was a similar problem of the discolored teeth in the family line. The clinical examination of this patient showed a symmetrical, brachyfacial face with straight profile (Figure 9). The intra-oral examination showed that this patient was in the very late mixed dentition (second permanent molars were not erupted yet). His oral hygiene was fair with upper midline shift 2 mm to the left, a Class I molar relationship on the right, and cusp-to-cusp on the left. The maxillary canines were still in the high positions, and lack of spaces for the alignment. Maxillary lateral incisors were lingual displacement with anterior cross-bite, and the maxillary dental arch was slightly constricted. Teeth were stain with yellow to brown in color, and most affected were premolars and anteriors. Enamel was hard and the surface was pitted. The panoramic radiograph showed all permanent teeth were present without any pathology (Figure 10). From the lateral cephalometric measurements (Figure 11), this patient presented with skeletal type I tendency III (ANB = 0.9°, AO-BO = -3.6 mm), open configuration (MP-PP = 27°, mandibular angle = 130.7°). Upper incisors were proclined (U1-NA = 34.8°) and lower incisors were retroclination (L1-NB = 22.7°). This patient

Measurement	Thai norm	Pretreatment	Posttreatment	Differences
NS-FH (°)	7 ± 2.58	9	10	1
SNA (°)	84 ± 3.58	87	88	1
SNB (°)	81 ± 3.59	86.5	87	0.5
ANB (°)	3 ± 2.50	0.5	1	0.5
AO-BO (mm)	-2 ± 3.49	-0.5	-0.5	0
NS-MP (°)	30 ± 5.61	33	32	-1
NS-PP (°)	9 ± 3.03	6.5	6	-0.5
MP-PP (°)	21 ± 5.25	27	26	-1
Mand angle	118 ± 6.13	126	125	-1
U1-NA (°)	22 ± 5.94	38.5	31	-7.5
U1-NA (mm)	5 ± 2.13	10	6	-4
L1-NB (°)	30 ± 5.61	30	24	-6
L1-NB (mm)	7 ± 2.22	8	6	-2
L1-MP (°)	97 ± 5.97	90	87	-3
U1-L1 (°)	125 ± 8.03	111	122.5	11.5
Nasolabial angle	91 ± 7.98	90	93	3
H-angle	14 ± 3.83	15.1	12	-3.1
L1-E plane (mm)	2 ± 2.03	4	2	-2

Table 2 Cephalometric values of pre- and posttreatment of case 1

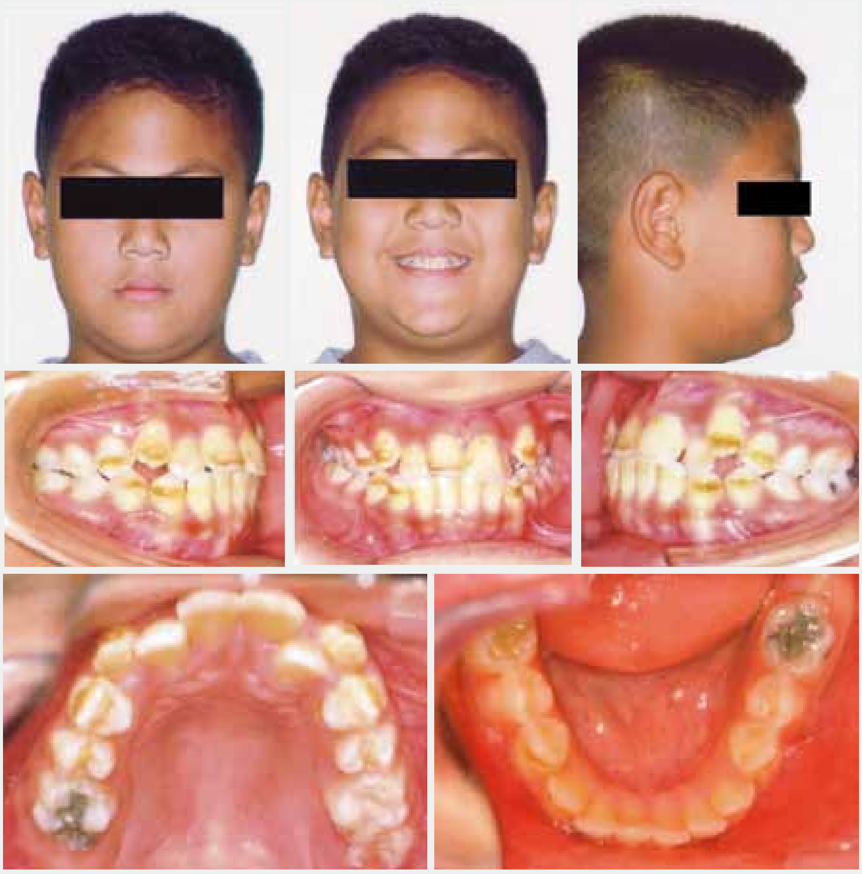

Figure 9 Case 2, pretreatment photographs

Figure 10 Case 2, pretreatment panoramic radiograph

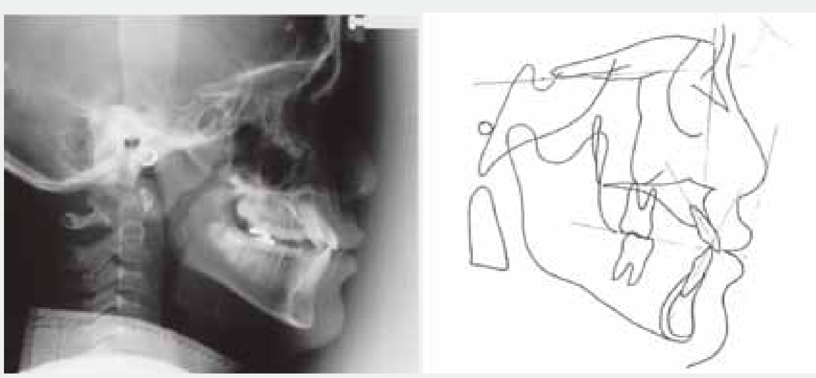

Figure 11 Case 2, pretreatment cephalometric radiograph and tracing

was diagnosed as the skeletal type I tendency III with Angle's Classification III subdivision, upper anterior crowding, and a hypoplastic type of amelogenesis imperfecta.

Treatment Plan

The main treatment objective of this patient was to expand the maxilla with rapid maxillary expansion (RME) to relieve maxillary anterior crowding and correct anterior cross-bite with full fixed orthodontic appliance, and to obtain Class I molar and canine relationships with normal overjet and overbite. Because of the discoloration of the anterior teeth and the young age of the patient, an interdisciplinary consultation with a pediatric dentist, a restorative dentist, and a prosthodontist were planned. After ideal dental and skeletal relationships were achieved, restorative treatment was required. Adhesive composite restoration, glass ionomer cement, veneer front teeth or crowns were explained to the patient for choices of restoration. The importance of oral hygiene, caries control, and cooperation was emphasized. The patient was told to see the pediatric dentist periodically. The patient and his parents gave their informed consent.

Treatment

A RME was inserted to correct the mild transverse discrepancy of the maxillary arch, to gain spaces for the maxillary canines, and to correct anterior crossbite of the maxillary lateral incisors (Figure 12 a). Standard 0.022" x 0.028" edgewise brackets with Roth prescription were placed on all maxillary and mandibular teeth for leveling and aligning. To maintain incisor torque and coordinate the dental arches, rectangular stainless steel wires were used in both arches. Because this patient presented with skeletal

a

b

Figure 12 Treatment progress of case 2
(a) using RME and (b) full fixed appliance.

type III tendency, mandibular growth had started and accelerated with growth spurt; therefore Class III elastics were used to control horizontal growth. Finally, this patient was told to wear the up and down elastics in order to seat the cusps (Figure 12 b).

Treatment Results

The posttreatment photographs show that the patient's profile was still straight profile, and the anterior crossbite was corrected to normal overjet and overbite. The posterior teeth illustrate good interdigitation, and the correction of crowding. Molar and canine Class I relationships were achieved on both sides (Figure 13). The treatment time of this patient was 3.6 years. The lateral cephalometric analysis after treatment (Figure 14 and Table 3) showed that the patient's skeletal was still within type I (ANB = -2.23°, AO-BO = -2.18 mm). The superimpositions (Figure 15) show the spurt of horizontal mandibular growth slightly greater than vertical growth (SNA = 82.18°, SNB = 84.42°). Maxillary incisors were slightly proclined and mandibular incisors were slightly retroclined (U1-NA = 39.8°, L1-NB = 19.67°). Patient's cooperation was good with care of his oral hygiene. After debonding and retention, patient was sent for restorative treatment of AI teeth: posterior crowns of molars and veneers of maxillary front teeth.

Figure 13 Case 2, posttreatment facial and intraoral photographs

Figure Post-treatment panoramic radiograph

Figure Post-treatment cephalometric radiograph

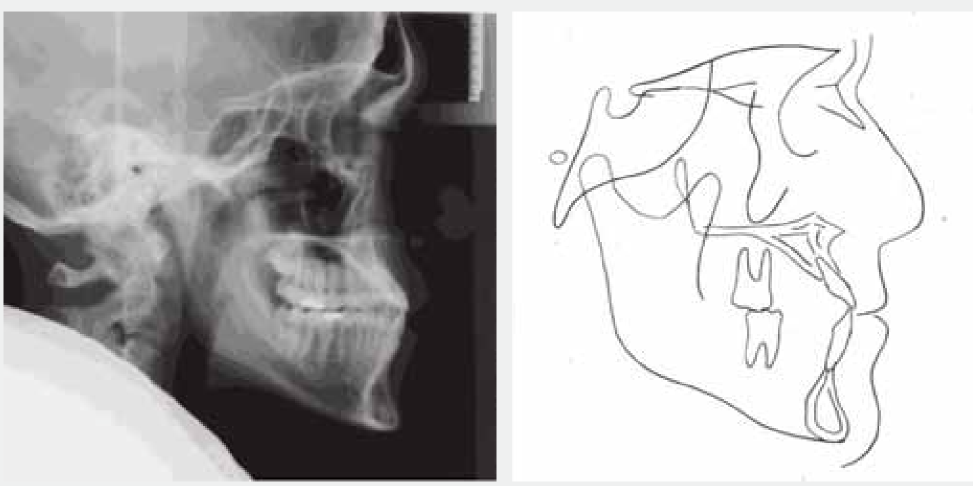

Figure 14 Case 2, posttreatment cephalometric radiograph and tracing.

Measurement	Thai norm	Pre-treatment	Post-treatment	Differences
NS-FH (°)	7 ± 2.58	7.94	5.76	-2.15
SNA (°)	84 ± 3.58	81.70	82.18	0.48
SNB (°)	81 ± 3.59	80.81	84.42	3.61
ANB (°)	3 ± 2.50	0.89	-2.23	-3.12
AO-BO (mm)	-2 ± 3.49	-3.57	-2.18	1.39
NS-MP (°)	30 ± 5.61	34.37	26.02	-8.35
NS-PP (°)	9 ± 3.03	6.58	5.74	-0.84
MP-PP (°)	21 ± 5.25	27.79	20.28	-7.51
Mand angle	118 ± 6.13	130.66	123.82	-6.84
U1-NA (°)	22 ± 5.94	34.85	39.80	4.95
U1-NA (mm)	5 ± 2.13	9.16	9.99	0.83
L1-NB (°)	30 ± 5.61	22.68	19.67	-3.01
L1-NB (mm)	7 ± 2.22	5.60	5.51	-0.09
L1-MP (°)	97 ± 5.97	87.50	89.24	1.74
U1-L1 (°)	125 ± 8.03	121.58	122.76	1.18
Nasolabial angle	91 ± 7.98	89.19	81.39	-7.80
H-angle	14 ± 3.83	14.42	7.29	-7.13
L1-E plane (mm)	2 ± 2.03	0.78	-3.25	-4.03

Table 3 Cephalometric values of pre- and posttreatment of case 2

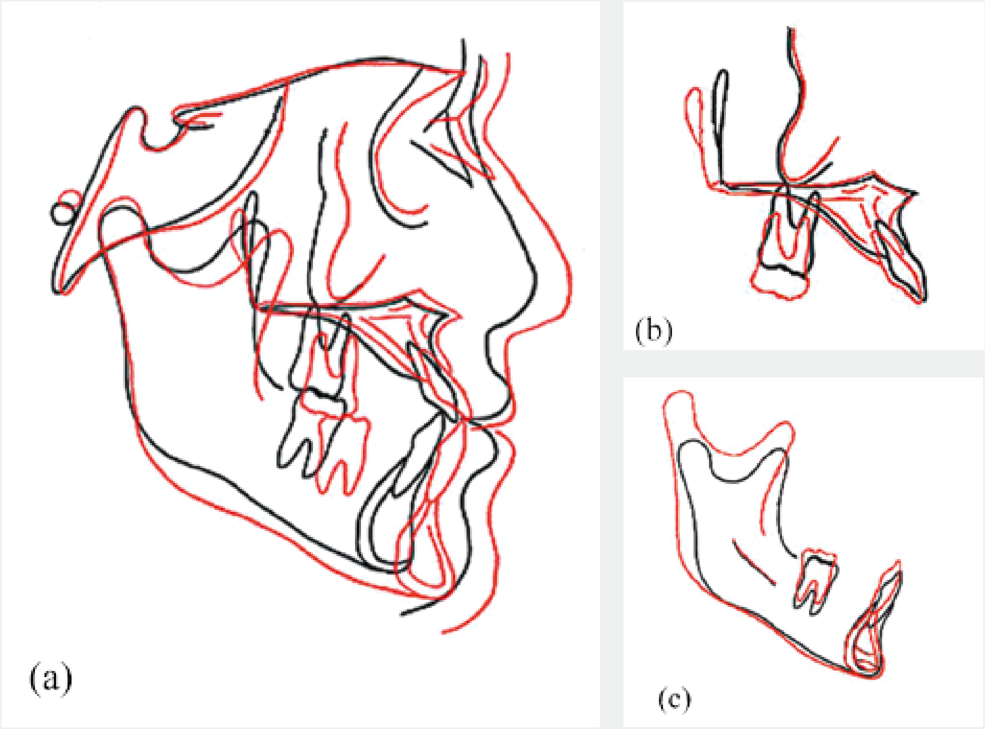

Figure 15 Case 2, cephalometric superimposition; (a) Cranial base, (b) Maxilla, (c) Mandible (black = pretreatment; red = posttreatment)

Figure 16 Case 2, recall intraoral photographs at 3 years retention with restorative treatment of maxillary front teeth. Posterior teeth show reduced enamel surfaces with some fractures and caries.

Because of the high cost for complete restorations, he wanted to do only maxillary incisor veneers. At 3 years retention he was called back, and it was found that his posterior teeth showed chips of enamel surfaces with extended caries (Figure 16). However, his occlusion was still in good interdigitation. This patient was told to have immediately crown procedure of the remaining affected AI teeth.

Discussion

Clinical problems of AI patients are usually associated with esthetics, oral health with tooth sensitivity, and dental caries. The interdisciplinary treatments that usually involved are adhesive restorative techniques with tooth-to reconstruction bond properties and prosthodontic rehabilitation of AI teeth. Consideration of AI patient's treatment modality includes a patient's age, severity of AI, periodontal condition, and financial implications for the patient's family, and long-term prognosis.(21-22) Because of normal enamel calcification, orthodontic management of these 2 cases was considered to use conventional resin composite bonding. Moreover, the information of these defected teeth and how to manage them were told to motivate patients for good cooperation and oral hygiene care.

Although these two cases were diagnosed as hypoplastic AI, the case-1 patient came for orthodontic treatment at the adult stage and the affected AI teeth showed thin, hard, smooth, and glossy enamel, which varied in color from white to cream-brown (Figure 1). This patient's clinical feature was subdivided into a smooth autosomal dominant hypoplastic type (Table 1).(15) While the case 2's AI teeth showed small, discrete, pinpoint-to-pinhead sized pits, which were arranged in horizontal rows (Figure 9). The case 2's clinical feature was subdivided into a pitted autosomal dominant hypoplastic type. In comparison, it seems that the case 1 teeth with smooth glossy enamels were shown lower severity than that of the case 2 with pitting surfaces, and with aged. During treatment, some brackets of the case 1 were dislodgement but no incidence of multiple bond failures, while in case 2 multiple bond failures were found and led to the increase of orthodontic treatment duration. Soew et al.(23) studied the effect of acid-etching on enamel from different clinical variants of AI and found that the pitted hypoplastic type showed a predominant etch pattern of type 1 in which the prism cores of enamel were preferential removed. In contrast, no typical etch patterns were found from the enamel affected by smooth hypoplastic variant. Moreover, high failure rates of adhesive restoration on AI affected teeth could be due to fractures within weak enamel or dentin supporting the restorations. In hypocalcified AI, pretreating the tooth surface with 5% sodium hypochlorite (NaOCl) for 1 minute would remove excess protein to make the enamel crystals more accessible to the etching solution resulting in enhancing the bonding of orthodontic brackets to the affected tooth.(24,25)

However, orthodontic treatments of these 2 cases were achieved; the case-1 patient treated with miniscrews to upright molars, and the case-2 patient treated with RME to correct crowding. Orthodontic retentions were provided with wraparound retainers in both cases, and the patients had been informed of new retainers in case that the old ones were not suitable with the restored AI affected teeth.

After orthodontic management, the cost of restorative or prosthodontic treatments in the AI patients was in consideration,[22] because the basic health insurance could not cover the overall cost of restorative and prosthodontic treatments. In case 2, therefore the patient wanted the anterior teeth to be restored first due to esthetics and financial limitation. The recall 3 years after treatment photographs of case 2 showed that the posterior teeth had reduced enamel surfaces and were prone to caries, while the case 1 was still observed without any problem.

Conclusion

The 2 cases report has been presented to illustrate the fact that patients who have the hypoplastic type of amelogenesis imperfecta can be successfully treated with conventional orthodontic appliances. The orthodontic management of AI patient has special conditions to be considerate as describe above. Moreover, the AI patients need to be continually motivated during and after orthodontic treatment using various techniques and appliances that aim to preserve the fragile tooth structure.

References

1. Weinman JP, Svoboda JF, Woods RW. Hereditary disturbances of enamel formation and calcification. J Am Dent Assoc 1945;32:397-418.
2. Aldred MJ, Crawford PJM, Roberts E, Gillespie CM, Thomas NT, Fenton I, Sandkuijl LA, Harper PS. Genetic heterogeneity in X-linked amelogenesis imperfecta. Genomics 1992a;14:567-73.
3. Aldred MJ, Crawford PJM, Roberts E, Thomas NST. Identification of a nonsense mutation in the amelogenin gene (AMELX) in a family with X-linked amelogenesis imperfecta (AIH1). Hum Genet 1992b;90:413-6.
4. Wright JT. The molecular etiologies and associated phenotypes of amelogenesis imperfecta. Am J Med Genet A 2006;140:2547-55.
5. Wright JT, Hart PS, Aldred MJ, Seow K, Crawford PJ, Hong SP, et al. Relationship of phenotype and genotype in X-linked amelogenesis imperfecta. Connect Tissue Res 2003;44(Suppl 1):72-8.
6. Kim JW, Seymen F, Lin BP, Kiziltan B, Gencay K, Simmer JP, et al. ENAM mutations in autosomal-dominant amelogenesis imperfecta. J Dent Res 2005;84:278-82.
7. Delsuc F, Gasse B, Sire JY. Evolutionary analysis of selective constraints identifies ameloblastin (AMBN) as a potential candidate for amelogenesis imperfecta. BMC Evol Biol. 2015;15:148.
8. Caterina JJ, Skobe Z, Shi J, Ding Y, Simmer JP, Birkedal-Hansen H, et al. Enamelysin (matrix metalloproteinase 20)-deficient mice display an amelogenesis imperfecta phenotype. J Biol Chem. 2002;277:49598-604.
9. Dong J, Amor D, Aldred MJ, Gu T, Escamilla M, MacDougall M. DLX3 mutation associated with autosomal dominant amelogenesis imperfecta with taurodontism. Am J Med Genet A. 2005;133A:138-41.
10. Stephanopoulos G, Garefalaki ME, Lyroudia K. Genes and related proteins involved in amelogenesis imperfecta. J Dent Res 2005;84:1117-26.
11. Chan HC, Estrella NM, Milkovich RN, Kim JW, Simmer JP, Hu JC. Target gene analyses of 39 amelogenesis imperfecta kindreds. Eur J Oral Sci 2011;119(Suppl 1):311-23.
12. Wang SK, Hu Y, Yang J, Smith CE, Richardson AS, Yamakoshi Y, el al. Fam83h null mice support a neomorphic mechanism for human ADHCAI. Mol Genet Genomic Med 2015;4:46-67.

13. Witkop CJ. Amelogenesis imperfecta, dentinogenesis imperfecta and dentin dysplasia revisited, problems in classification. J Oral Pathol 1989;17:547–53.
14. Aldred MJ, Savarirayan R, Crawford PJ. Amelogenesis imperfecta: a classification and catalogue for the 21st century. Oral Dis 2003;9:19–23.
15. Seow WK. Clinical diagnosis and management strategies of amelogenesis imperfecta variants. Pediatr Dent 1993;15:384-93.
16. Aren G, Ozdemir D, Firatli S, Uygur C, Sepet E, Firatli E. Evaluation of oral, systemic manifestations in an amelogenesis imperfecta population. J Dent 2003;31:585-91.
17. Pavliĉ A, Battelino T, Podkrajsek KT, Ovsenik M. Craniofacial characteristics and genotypes of amelogenesis imperfecta patients. Eur J Orthod 2011;33:325-31.
18. N. Arkutu, K. Gadhia, S. McDonald, K. Malik, L. Currie. Amelogenesis imperfecta : the orthodontic prespective. Br Dent J 2012;212:485-9.
19. Gisler V, Enkling N, Zix J, Kim K, Kellerhoff NM, Mericske-Stern R. A multidisciplinary approach to the functional and esthetic rehabilitation of amelogenesis imperfecta and open bite deformity: a case report. J Esthet Restor Dent 2010;22:282-93.
20. Bishara SE, Ostby AW. Bonding and debonding from metal to ceramic: Research and its clinical application. Semin Orthod. 2010;16: 24- 36.
21. Millet C, Duprez JP, Khoury C, Morgon L, Richard B. Interdisciplinary Care for a Patient with Amelogenesis Imperfecta: A Clinical Report. J Prosthodont 2015;24:424-31.
22. Patel M, McDonnell ST, Iram S, Chan MF. Amelogenesis imperfecta – lifelong management. Restorative management of the adult patient. Br Dent J 2013;215:449-57.
23. Seow WK, Amaratunge A. The effects of acid-etching on enamel from different clinical variants of amelogenesis imperfecta: an SEM study. Pediatr Dent 1998;20:37-42.
24. Venezie RD, Vadiakas G, Christensen JR, Wright JT. Enamel pretreatment with sodium hypochlorite to enhance bonding in hypocalcified amelogenesis imperfecta: case report and SEM analysis. Pediatr Dent 1994;16:433-36.
25. Saroğlu I, Aras S, Oztaş D. Effect of deproteinization on composite bond strength in hypocalcified amelogenesis imperfecta. Oral Dis 2006;12:305-08.

บทความปริทัศน์
Review Article

การกระตุ้นการเจริญของขากรรไกรบน ในผู้ป่วยเด็กที่มีการสบฟันผิดปกติประเภทที่ 3

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บทคัดย่อ

การสบฟันผิดปกติประเภทที่ 3 นั้นเกิดจากการเจริญของขากรรไกรบนที่น้อย หรือการเจริญของขากรรไกรล่างที่มาก หรือเกิดจากทั้งสองปัจจัยร่วมกัน ในชาวเอเชียที่มีความผิดปกติของการสบฟันนั้น พบว่ามีคนไข้ที่มีการสบฟันผิดปกติประเภทที่ 3 ถึง 68% โดยพบว่าสาเหตุเกิดจาก ขากรรไกรบนที่เจริญน้อยเป็นส่วนใหญ่ เนื่องจากคนไข้ในกลุ่มนี้มักมีความผิดปกติของขากรรไกรบนทั้งในแนวหน้าหลังและในแนวดิ่ง ทำให้ขากรรไกรล่างมีการหมุนแบบทวนเข็มนาฬิกา ส่งผลให้ขากรรไกรล่างยื่น นอกจากนี้ คนไข้กลุ่มนี้มักมีการชดเชยของฟัน, ฟันหน้าสบคร่อม, ฟันสบกระแทก, สบไถล, ฟันหน้าล่างสึกและมีเหงือกร่น การลดปัญหาเหล่านี้รวมทั้งส่งเสริมให้ขากรรไกรบนสามารถเจริญได้ตามปกตินั้น สามารถทำได้โดยการกระตุ้นการเจริญของขากรรไกรบนตั้งแต่ช่วงที่ยังมีการเจริญเติบโต นอกจากนี้การรักษายังส่งผลให้คนไข้มีใบหน้าดูดีขึ้น รวมทั้งลดโอกาสในการรักษาโดยการผ่าตัดในอนาคตอีกด้วย วิธีการรักษาคนไข้ที่มีขากรรไกรบนเจริญน้อย คือการให้แรงกระตุ้นขากรรไกรบนให้เจริญและปรับเปลี่ยนทิศทางการเจริญให้มีเจริญมาทางด้านหน้าและลงล่าง โดยเครื่องมือที่มักใช้ ได้แก่ เครื่องมือฟังชันนอล, เครื่องมือขยายขากรรไกรบนอย่างรวดเร็วและเฟสแมสก์ บทความนี้มีวัตถุประสงค์เพื่ออธิบายโดยสรุป เกี่ยวกับประสิทธิภาพของการใช้เครื่องมือเหล่านี้ต่อขากรรไกรและฟัน

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Maxillary Protraction Therapy for Class III Growth Modification

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Abstract

Class III malocclusion is associated with deficiency of the maxilla, or the overgrowth of the mandible, or the combination of both. The prevalence of this type of malocclusion in Asian population is 68% and the origin of malocclusion is retrognathic maxilla. Because of deficiency in maxilla both in antero-posterior and vertical

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dimension, the mandible usually rotates upward and forward leading to prognathic mandible. Moreover, these patients usually have dental compensation, anterior crossbite, traumatic occlusion, functional shift, abnormal wear and gingival recession of lower incisors. To minimize these problems and provide favorable growth of maxilla in class III growing patients, early orthopedic treatment should be provided. Moreover, the treatment may improve facial appearance and reduce the chance of orthognathic surgery in the future. Treatment strategy for class III maxillary deficiency is to apply orthopedic forces to the maxilla to stimulate and redirect growth of the maxilla in forward and downward direction. The appliances that are generally used are functional appliance, rapid maxillary expander and protraction facemask. The purpose of this article is to provide an overview of effectiveness of these appliances on skeletal and dental changes.

Keywords: Class III, orthopedic treatment, maxilla

Introduction

Class III malocclusion is associated with the antero-posterior relationship deviation of the maxilla and the mandible. It can be described as the deficiency and/or a backward position of the maxilla, or the overgrowth and/or forward position of the mandible, or the combination of both.

The prevalence of this type of malocclusion in European population (1-5%) is less than the Asian (9-19%). Asian Class III malocclusion is usually of retrognathic maxilla origin, whereas a high prevalence of prognathic mandible is found among European Class III patients.[1] Moreover, another study investigated the prevalence of dentofacial deformities in Asian population and found that 68% of patients had skeletal class III pattern.[2]

Class III malocclusion is normally caused by an interaction of hereditary and environmental factors. The influence of the acute cranial base angle, short and retrusive maxilla, prominent and prolong active growth of mandible, and ventral position of the mandibular articulation prohibit the occurrence of Class III malocclusion.[3] In addition, habits and mouth breathing may play a role in excessive mandibular growth.[4]

Class III skeletal growth pattern of maxilla

Considering the Class III maxillary growth, the maxilla shows a retrusive position at an early development stage and retains a constant anteroposterior relationship to the cranial base structures with continued development. The horizontal A point movement is approximately 0.4 mm/year which is less forward movement than 1.0 mm/year in patients with a class I malocclusion.[5]

The percentage of children with maxillary anteroposterior discrepancy problems increases from 26% to 44% to 37% as the dentition progress from primary, mixed, and permanent dentition respectively.[6] So, class III growth characteristics appear to persist beyond the adolescent growth spurt into early adulthood, and Class III disharmony tends to worsen with growth and this malocclusion is not self-corrected at either the skeletal or the occlusal levels.

Rationale and timing for growth modification in class III maxillary deficiency

Because of deficient maxillary growth in antero-posterior and vertical dimensions, the mandible might be expected to rotate upward and forward. This feature leads to an even more mandibular prognathic appearance. Class III malocclusion is often accompanied with an anterior crossbite, consequently, leading to functional shift, abnormal wear of the lower incisors, dental compensation of mandibular incisors, thinning of the labial alveolar plate and/or gingival recession. To minimize these problems and provide a more favorable environment for future growth, early orthopedic treatment is needed. Moreover, this treatment may simplify phase II comprehensive treatment and reduce the necessity for orthognathic surgery and can improve lip posture and facial appearance.

It is impossible to move the mandible backward, but moving the maxilla forward is possible by protraction devices.[7] So, the treatment should be performed to promote and encourage the maxillary growth. The optimum treatment timing for class III maxillary deficiency is at the time of maxillary permanent incisors eruption, up to the age of 10. Within this ages, the positive overjet and overbite can provide the proper environment for maxillary growth and it is easy and effective to move the maxilla forward by sutural growth.

Treatment strategies for class III maxillary deficiency

One treatment approach to Class III maxillary deficiency is maxillary orthopedics. This method requires an application of orthopedic forces to the maxilla to stimulate and redirect growth of the maxilla in forward and downward direction. The movement of maxilla is based on the sutural growth concept. To move the maxilla into a more anterior and inferior position, the force should be applied to produce tensile force between sutural surface and the bone should be added at the posterior and superior sutures. Animal studies have shown that maxillary protraction is possible. Dellinger[8] used two Macaca Speciosa monkeys and reported that the maxilla can be moved forward by means of 6 pounds of force delivered for 7 days. Kambara[9] used 300 g of intermittent force on six Macaca Irus monkeys with five controls and showed that the maxillary complex can be displaced anteriorly.

A few clinical studies have shown that retruded maxilla could be moved forward by extraoral forces. Oppenheim[7] suggested that a headgear with chin cup can be used to protract the maxillary posterior teeth. Improvement in the Class III relationship of the dentition by means of elastics attached to wires on a chin cup using the neck or head of the patient as anchorage has also been reported. Jackson et al[10] reported that protraction headgear affected the circumaxillary and deeper maxillary sutures. Haas[11] reported that rapid maxillary expansion (RME) produces a slight forward movement of point A and a slightly downward and forward movement of the maxilla. According to McNamara[12] and Turley[13], RME may also serve to interrupt the maxillary suture system and enhance the protraction effect of the facemask. So, treatments that affect the suture can be used for maxillary protraction such as functional appliance, RME, protraction facemask.

Functional appliance: Frankel III Functional Regulator

The Frankel III (FRIII) regulator is the functional appliance acting on maxillary complex by the muscle force. The vestibular shields of this appliance are place in the depth of the sulcus to stretch the periosteum and facilitate forward development of the maxilla. The effectiveness is dependent on patient cooperation and wearing them full time. The effect of this appliance is minimally in the change of maxilla position, but mainly on dental movement and backward rotation of mandible.[14]

Rapid Palatal Expansion (RPE) or Rapid Maxillary Expansion (RME)

Maxillary expansion has been advocated as an important part of maxillary protraction with facemask therapy. Rapid palatal expansion is easily accomplished in a growing patient because the less interlock of the sutures and leads to downward and forward movement of A-point of approximately 1.5 mm, more significant widening at the canine-premolar region than at the molar region, and downward and backward rotation of the mandible, thus increasing lower face height.[15]

The benefits of RPE include correcting crossbite, splinting the maxillary dentition as a unit for maxillary protraction, and disarticulation of the circumaxillary sutures that pronounces the orthopedic effect. But from a clinical trial[16], both the expansion and the nonexpansion groups demonstrated significant skeletal change relative to the control group: there was no significant difference in the skeletal correction achieved in expansion and nonexpansion group.

Protraction facemask therapy

The one of common and popular appliance to correct the class III malocclusion with maxillary deficiency is the orthopedic protraction facemask appliance. The facemask has an adjustable anterior wire that can produce a downward and forward pull on the maxilla by elastics that angle to the occlusal plane about 30 degrees. Maxillary protraction usually requires 300 to 600 g of force per side. Patients are instructed to wear the appliance for 12 hours per day.[17]

The facemask applies tensile force on the circumaxillary sutures and thereby stimulate bone apposition in the suture areas. So, the facemask is effective in late primary and mixed dentition when the sutures are still smooth and broad (8 to 10 years of age).[18]

The treatment effects of the protraction face mask appliance are a combination of skeletal and dental changes of the maxilla and mandible. The maxilla moves downward and forward with slightly anticlockwise rotation of palatal plane as the result of protraction force; at the same time, upper posterior teeth are extruded and upper anterior teeth are proclined. Consequently, downward and backward rotation of the mandible is occurred and improves the maxillomandibular skeletal relationship in the sagittal dimension but results in an increase in lower anterior facial height.[19]

Biomechanic considerations for maxillary protraction

The results from the facemask are different upon patient's cooperation and application. Considering the force system, four important factors for adjustments of the protraction facemask are magnitude, direction and point, duration of force, and force constancy.[20]

First, the force applied to the maxilla disassociates the sutural articulation and leads to the apposition and resorption process, resulting in displacement of maxilla. So, the more interdigitation of suture that more interlock with age, the higher force is needed to achieve the movement of maxilla.

Second, the center of resistance of maxilla is located between the root tip of the maxillary first and second premolars.[21] By determining the point of protraction force, the vertical dimension of the face can be manipulated. A force below the level of the occlusal plane may be more desirable to rotate the mandible downward and backward in class III deepbite patients.

Third, daily wear time depends also on the age of the patient. In preadolescent patients, 10-12 hours of use per day is sufficient. In adolescent patients, it may be necessary to increase the wear time to 12 to 16 hours per day. The latter group may also have problems with compliance.

Last, the force applied with elastics should be measured at the beginning to determine the desired force level. Patients should be instructed to use fresh elastics as much as possible for constant force level because elastics has force degradation 50-70% in 24 hours after use.

Alternatives for maxillary protraction

Besides the basic type of the protraction facemask, there are a various alternatives, fixed and removable, for protraction of maxilla, correction of anterior crossbite, and providing the proper environment for maxillary growth. With the fixed appliances, the need for patient compliance is reduced, and effectiveness of treatment outcome is increased. The fixed appliance like Quick fix with 2x4 appliance can produce the forward movement of upper incisors and correct anterior crossbite. Nevertheless, the orthopedic effect for protraction of maxilla from this appliance is questionable because the appliance is acting only on the teeth and the produced force is not orthopedic force.[22] Whereas, Fixed Reverse Labial Bow[23] and Alternate Rapid Maxillary Expansion and Constriction (Alt-RAMEC)[24] have been designed to produce the orthopedic force but need the particular components and skill to use these appliances. Alt-RAMEC was designed to maintain mid-palatal suture stimulation for longer period compared with rapid palatal expansion (RPE), leads to achieving greater maxillary protraction in class III growing patients.[25] To activate the appliance, the expander is activated 1 mm per day, one week for expansion and one week for constriction. This procedure is repeated for 7-9 weeks and use intraoral springs for class III correction.[26]

Regarding removable appliances that have been modified from the protraction facemask, these appliances have been designed for patient’s comfortable, easy to fabricate, and reduce the undesirable effect from the protraction facemask like over proclination of upper incisors, rotation of palatal plane, or the less orthopedic effect. Examples of these appliance are TTBA (the Tandem Traction Bow Appliance)[27], Lever-Hook Edgewise Arch for Midfacial Protraction[28], Mini-Maxillary Protractor for Class III Correction.[29]

Limitation of maxillary protraction

The outcome of the early treatment is variable and dependent largely on many factors such as cause of the deformity and the age of the initial intervention. There have been numerous reports about the effective of orthopedic protraction facemask appliance. From many of previous studies in treatment effect on the maxilla, a greater portion of the changes from this appliance are not orthopedic, but rather be dentoalveolar change by proclination of upper incisors as shown in table 1.

Author/year	age	Tx time (months)	Appliances	Treatment Effect
Sung SJ & Biak HS /1998 [30]	7-13	8-9	RPE+ Delaire's facemask	A-point horizontal change 2.15mm UI horizontal change 3.37mm
Gu Y et al / 2000[31]	8.5	10.6	RPE+reverse HG	Skeletal change 23%, Dental change 77 %
Hiyama S et al /2002[32]	9.8	12	MPS	SNA change 1.3 degree U1 - SN change 6.2 degree
Vaugh GA et al /2005[16]	5-10		RPE+Facemask	U1 to NA 1.23 mm, SNA change 3.02 degree A point horizontal change 2.41 mm
Shanker S et al/1996[33]	8.4	12	Hyrax RPE +Facemask	Dental change 25% Skelatal change 75%(Protracting force 400 gm)
Nartallo-Turley PE & Turley PK /1998 [34]	8.3	10	RME+Facemask	SNA change 2.35 degree U1 horizontal change 1.75 mm
Ngan P et al/1996[35]	8.1	6	RPE+Facemask	SNA change 1.3 degree U1 - SN change 3.4 degree
Nienkemper M et al /2013[36]	9.5	5.8	Hybrid hyrax + Facemask	SNA change 2 degree Overjet +2.7 mm
Ngan P and Moon W / 2015[37]	9.8	6	Tooth-borne RPE + Facemask	U1 horizontal change 1.32 mm, SNA change 0.69 degree, A point horizontal change 1.53 mm
	9.6	6	Bone-borne RPE + Facemask	U1 horizontal change 2.19 mm, SNA change 1.59 degree, A point horizontal change 1.54 mm

Table 1: The treatment effect of maxillary protraction therapy on maxilla and upper incisors

From the study of Gu et al 2000[31], the skeletal changes contributed 23% and dental changes contributed 77% of overjet correction in the reverse headgear group during the total observation period. Comparing to 2x4 group, dental changes appeared to contribute more to the total overjet correction. At the end of treatment, there was no significant difference in the position of the incisors between the two groups.

From the study of Sung et al 1998[30], the effects of protraction facemask on upper incisors were proclination and relative intrusion. In protraction facemask group, upper incisors were displaced forward 3.4 mm while the movement of A point that represent the displacement of maxilla was 2.15 mm; the dental effect was about 2 times of skeletal effect. In vertical dimension, upper incisors were displaced downward 1.85 mm, compared with 2.6 mm in normal growth of class I untreated patients. These results can be showed that the face mask cannot accomplish the forward and downward movement of maxilla as the amount and direction of normal maxillary growth and may lead to un-esthetic results.

About the stability of treatment, studies found that 2 year follow up showed the settling of the occlusion and no relapse of the anterior crossbite.[38, 39] However, from the study of Baccetti[40], relapse following treatment has been seen in certain patients after growth has been completed. Although, amount of forward and downward maxillary displacement measured at A-point were greater than that in the Class I control group during treatment period. However, during the observation period of 1 year following protraction, the amount of maxillary growth in the protraction group was found to be less than the control group, indicating the possibility of short-term relapse.

Furthermore, some of the appliances used can be uncomfortable by extraoral component that placed on forehead and chin at least half of a day, and the treatment time can be long. Consequently, the cooperation from many of these patients may be poor, negatively influencing the treatment effects.

Conclusion

In growing patients with class III malocclusion and maxillary deficiency, forward and downward movement of the maxilla is the main treatment objective of growth modification. To achieve this goal, many appliances have been designed and used for protraction of maxilla in proper amount and direction. Although the treatment outcomes of protraction facemask vary and may not exhibit the expected results, it is commonly used because any extent of downward movement of the maxilla will result in mandibular clockwise rotation that can reduce class III skeletal discrepancy. The patient cooperation is one of the major factors for the treatment effect. The more complication and uncomfort of using the appliance, the less children cooperation. In the future, there should be new appliances which are comfortable, easy to use, need less patient cooperation and can produce the amount and direction of maxillary movement similar to or better than protraction facemask as alternative treatment options for these patients.

References

1. Ngan P, Hagg U, Yiu C, Merwin D, Wei SH. Cephalometric comparisons of Chinese and Caucasian surgical Class III patients. Int J Adult Orthodon Orthognath Surg 1997;12(3):177-88.
2. Chew MT. Spectrum and management of dentofacial deformities in a multiethnic Asian population. Angle Orthod 2006;76(5):806-9.

3. Baccetti T, Reyes BC, McNamara JA, Jr. Craniofacial changes in Class III malocclusion as related to skeletal and dental maturation. Am J Orthod Dentofacial Orthop 2007;132(2):171.e1-71.e12.
4. Battagel JM. The aetiological factors in Class III malocclusion. Eur J Orthod 1993;15(5):347-70.
5. Nanda RS, Ghosh J. Longitudinal growth changes in the sagittal relationship of maxilla and mandible. Am J Orthod Dentofacial Orthop 1995;107(1):79-90.
6. Dietrich UC. Morphological variability of skeletal Class III relationships as revealed by cephalometric analysis. Rep Congr Eur Orthod Soc 1970:131-43.
7. Oppenheim A. A possibility for physiologic orthodontic movement. Dent Rec (London) 1945;65:278-80.
8. Dellinger EL. A preliminary study of anterior maxillary displacement. Am J Orthod 1973;63(5):509-16.
9. Kambara T. Dentofacial changes produced by extraoral forward force in the Macaca irus. Am J Orthod 1977;71(3):249-77.
10. Jackson GW, Kokich VG, Shapiro PA. Experimental and postexperimental response to anteriorly directed extraoral force in young Macaca nemestrina. Am J Orthod 1979;75(3):318-33.
11. Haas AJ. Palatal expansion: just the beginning of dentofacial orthopedics. Am J Orthod 1970;57(3):219-55.
12. McNamara JA, Jr. An orthopedic approach to the treatment of Class III malocclusion in young patients. J Clin Orthod 1987;21(9):598-608.
13. Turley PK. Orthopedic correction of Class III malocclusion with palatal expansion and custom protraction headgear. J Clin Orthod 1988;22(5):314-25.
14. Baik HS, Jee SH, Lee KJ, Oh TK. Treatment effects of Frankel functional regulator III in children with class III malocclusions. Am J Orthod Dentofacial Orthop 2004;125(3):294-301.
15. Wertz RA. Skeletal and dental changes accompanying rapid midpalatal suture opening. Am J Orthod 1970;58(1):41-66.
16. Vaughn GA, Mason B, Moon HB, Turley PK. The effects of maxillary protraction therapy with or without rapid palatal expansion: a prospective, randomized clinical trial. Am J Orthod Dentofacial Orthop 2005;128(3):299-309.
17. Ngan P. Early treatment of Class III malocclusion: is it worth the burden? Am J Orthod Dentofacial Orthop 2006;129 (4 Suppl):S82-5.
18. Melsen B, Melsen F. The postnatal development of the palatomaxillary region studied on human autopsy material. Am J Orthod 1982;82(4):329-42.
19. Kim JH, Viana MA, Graber TM, Omerza FF, BeGole EA. The effectiveness of protraction face mask therapy: a meta-analysis. Am J Orthod Dentofacial Orthop 1999;115(6): 675-85.
20. Nanda R. Biomechanics and esthetic strategies in clinical orthodontics. St. Louis, Mo.: Elsevier Saunders,; 2005. p. 1 online resource (xiii, 385 p.).
21. Tanne K, Sakuda M. Biomechanical and clinical changes of the craniofacial complex from orthopedic maxillary protraction. Angle Orthod 1991;61(2):145-52.
22. Bowman SJ. A quick fix for pseudo-Class III correction. J Clin Orthod 2008;42(12):691-7; quiz 727.
23. Carano A, Bowman SJ, Valle M. A fixed reverse labial bow for moderate Class III interceptive treatment. J Clin Orthod 2003;37(1):42-6.
24. Liou EJ. Toothborne orthopedic maxillary protraction in Class III patients. J Clin Orthod 2005;39(2):68-75.
25. Liou EJ. Effective maxillary orthopedic protraction for growing Class III patients: a clinical application simulates distraction osteogenesis. Prog Orthod 2005;6(2):154-71.
26. Franchi L, Baccetti T, Masucci C, Defraia E. Early Alt-RAMEC and facial mask protocol in class III malocclusion. J Clin Orthod 2011;45(11):601-9.
27. Chun YS, Jeong SG, Row J, Yang SJ. A new appliance for orthopedic correction of Class III malocclusion. J Clin Orthod 1999;33(12):705-11.
28. Vesco HL. Lever-hook edgewise arch for midfacial protraction. J Clin Orthod 1999;33(3):160-6.
29. Altug Z, Arslan AD. A mini-maxillary protractor for Class III correction. J Clin Orthod 2005;39(9):522-5; quiz 31.
30. Sung SJ, Baik HS. Assessment of skeletal and dental changes by maxillary protraction. Am J Orthod Dentofacial Orthop 1998;114(5):492-502.
31. Gu Y, Rabie AB, Hagg U. Treatment effects of simple fixed appliance and reverse headgear in correction of

anterior crossbites. Am J Orthod Dentofacial Orthop 2000;117(6):691-9.

32. Hiyama S, Suda N, Ishii-Suzuki M, et al. Effects of maxillary protraction on craniofacial structures and upper-airway dimension. Angle Orthod 2002;72(1):43-7.
33. Shanker S, Ngan P, Wade D, et al. Cephalometric A point changes during and after maxillary protraction and expansion. Am J Orthod Dentofacial Orthop 1996;110(4):423-30.
34. Nartallo-Turley PE, Turley PK. Cephalometric effects of combined palatal expansion and facemask therapy on Class III malocclusion. Angle Orthod 1998;68(3):217-24.
35. Ngan P, Hagg U, Yiu C, Merwin D, Wei SH. Soft tissue and dentoskeletal profile changes associated with maxillary expansion and protraction headgear treatment. Am J Orthod Dentofacial Orthop 1996;109(1):38-49.
36. Nienkemper M, Wilmes B, Pauls A, Drescher D. Maxillary protraction using a hybrid hyrax-facemask combination. Prog Orthod 2013;14:5.
37. Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J Orthod Dentofacial Orthop 2015;148(1):22-36.
38. Rabie AB, Gu Y. Management of pseudo Class III malocclusion in southern Chinese children. Br Dent J 1999;186(4 Spec No):183-7.
39. Wiedel AP, Bondemark L. Stability of anterior crossbite correction: a randomized controlled trial with a 2-year follow-up. Angle Orthod 2015;85(2):189-95.
40. Baccetti T, Franchi L, McNamara JA, Jr. Treatment and posttreatment craniofacial changes after rapid maxillary expansion and facemask therapy. Am J Orthod Dentofacial Orthop 2000;118(4):404-13.

บทความปริทัศน์
Review Article

การทบทวนวรรณกรรมอย่างมีระบบเกี่ยวกับความแตกต่างของการรับรู้ความเจ็บปวดระหว่างเซลฟ์ไลเกตติ้งแบร็กเก็ต (Self-ligating bracket) และแบร็กเก็ตแบบดั้งเดิม (Conventional bracket)

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บทคัดย่อ

วัตถุประสงค์ : การศึกษานี้มีวัตถุประสงค์เพื่อเปรียบเทียบการรับรู้ความเจ็บปวดระหว่าง แบร็กเก็ตแบบดั้งเดิมและเซลฟ์ไลเกตติ้งแบร็กเก็ต

วิธีการ : ในเบื้องต้นศึกษาจากฐานข้อมูลอิเล็กทรอนิกส์ 3 แหล่งได้แก่ สโกปัส (Scopus), พับเมด (Pubmed), และ เว็บอ๊อฟซายด์ (ISI) โดยทำการสืบค้นข้อมูลจนกระทั่งถึงเดือนกรกฎาคม พ.ศ. 2558 คำที่ใช้ในการสืบค้นคือ (“self-ligat*”) AND (“conventional bracket” OR “conventional brace”) AND (“pain” OR “discomfort”) ในเบื้องต้น ชื่อเรื่องและบทคัดย่อของการวิจัยที่ถูกค้นพบจะได้รับการคัดกรอง และคัดเลือกจากหลักเกณฑ์การนำเข้าและตัดออก การวิจัยที่ผ่านการคัดกรองในขั้นแรกจะถูกนำมาศึกษาต่อด้วยการหาบทความฉบับเต็ม บทความที่ตรงตามเกณฑ์การคัดกรองจะถูกนำมาใช้ในการทบทวนวรรณกรรม อย่างเป็นระบบนี้

ผลการทดลอง : จาก 8 การศึกษาที่ตรงตามเกณฑ์การคัดเลือก มี 6 การศึกษาที่เป็นการทดลองแบบสุ่ม และ 2 การศึกษาเป็นการทดลองทางคลินิกแบบมีกลุ่มควบคุม ครึ่งหนึ่งของการศึกษารายงานว่าไม่มีความแตกต่าง อย่างมีนัยสำคัญทางสถิติของระดับความเจ็บปวดระหว่าง แบร็กเก็ตแบบดั้งเดิมและเซลฟ์ไลเกตติ้งแบร็กเก็ต มี 2 การศึกษารายงานว่า เซลฟ์ไลเกตติ้งแบร็กเก็ตให้ระดับความเจ็บปวดที่น้อยกว่าแบร็กเก็ตแบบดั้งเดิม ในขณะที่การศึกษาที่เหลือรายงานว่า แบร็กเก็ตแบบดั้งเดิมให้ระดับความเจ็บปวดที่น้อยกว่า

สรุป : จากการทบทวนวรรณกรรมอย่างมีระบบเกี่ยวกับความแตกต่างของการรับรู้ความเจ็บปวดระหว่าง เซลฟ์ไลเกตติ้งแบร็กเก็ต (Self-ligating bracket) และ แบร็กเก็ตแบบดั้งเดิม (Conventional bracket) ในปัจจุบันยังไม่สามารถสรุปได้ว่าแบร็กเก็ตชนิดใดที่สามารถลดการรับรู้ความเจ็บปวดได้มากกว่า

คำสำคัญ : แบร็กเก็ตแบบดั้งเดิม เซลฟ์ไลเกตติ้งแบร็กเก็ต ความเจ็บปวด การรักษาทางทันตกรรมจัดฟัน

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Differences in Pain Perception Associated with Self-ligating and Conventional Bracket: a Systematic Review

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Abstract

Objective: The aim of this study was to systematically compare pain perception between conventional (CB) and self-ligating brackets (SLB).

Method: 3 major electronic databases, namely Scopus, Pubmed and Web of Science (ISI), were searched over the period until July 2015. Each databases were searched by using the term ("self-ligat*") AND ("conventional bracket" OR "conventional brace") AND ("pain" OR "discomfort"). Initially, titles and abstracts screening were done and selected according to the inclusion and exclusion criteria, followed by retrieval of the full-texts. Articles that fulfilled the selection criteria were identified for this systematic review.

Result: Eight studies met the inclusion criteria, including 6 randomized controlled trial and 2 clinical control trial. Half of the included studies reported no statistically significant difference between CB and SLB in term of pain intensity. The claims of superiority of self-ligating brackets were supported by two studies while the rest were in favor of conventional bracket.

Conclusion: From this systematic review regarding differences in pain perception associated with self-ligating and conventional bracket, it is still inconclusive which bracket system serves its purpose best in term of reduction in pain perception.

Key word: conventional brackets, self-ligating brackets, pain, discomfort, orthodontic treatment

Introduction

It seems logical that pain and discomfort are inevitable during the course of orthodontic tooth movement which has been reported a number of times in various journals and articles.

When it comes to choosing the type of bracket, two sets of bracket system are generally available namely the self-ligating and the conventionally ligated bracket type. While the self-ligating claims of superiority in providing fuller arch wire engagement with low frictional force between the bracket and the arch wire, it also boasts of requiring less chair side assistance and allowing faster arch wire insertion and removal [1]. It also reports promotion of periodontal health and a reduction of overall treatment time and a similar decrease in required appointments [1, 2]. But one aspect they both share in common is the ability to cause pain and discomfort which most of the times has resulted in poor patient compliance and discontinuation of treatment often raising fear in the uptake of orthodontic care [3-5].

Several researches compared the therapeutic efficiency, friction, speed of archwire changes, therapeutic time and initial alignment of the mandibular arch between self-ligating and conventional brackets including studies of pain and discomfort and oral health related quality of life in patients wearing conventional and self-ligating brackets [6-11]. A randomized clinical trial studied the oral health related quality of life in both self-ligating and conventional bracket system and found out that no bracket system offers superior quality of life in related to oral health [11]. It is therefore in our interest to compare the two bracket systems in pain and discomfort perception.

Materials & methods

Selection criteria

The inclusion and exclusion criteria were provided in Table 1. To be included, the study had to be a randomized clinical trial (RCT) or clinical controlled trial (CCT), however, the split mouth study design was excluded from the review. The retrieved study should report the outcome in terms of pain intensity, including visual analog scale (VAS) or any other equivalent scales, and compare the different between treating with conventional bracket and self-ligating bracket.

Inclusion criteria	Exclusion criteria
1. Study design: randomized clinical trials (RCTs) or controlled clinical trials (CCTs).	1. Non-English publication.
2. Participants: patients with full-arch, fixed, and bonded orthodontic appliances.	2. Studies not conducted in clinical setting, included in vitro and animal studies.
3. Interventions and comparators: orthodontic treatment involved with any types of self-ligating and conventional metal brackets.	3. Split-mouth study design.
4. Outcome measures: pain intensity during orthodontic treatment.	4. Review, systematic review, and editorial commentaries articles.
	5. Study with no comparison group or not comparing between conventional metal bracket and self-ligating bracket.

Table 1. Inclusion and exclusion criteria.

Search strategy

According to Figure 1, this systematic review was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Articles were searched through the following electronic databases: (1) Pubmed, (2) SCOPUS, and (3) Web of Science, covered the period until July, 2015. Each databases were searched by using the term ("self-ligat*") AND ("conventional bracket" OR "conventional brace") AND ("pain" OR "discomfort").

After compiling the list of included studies, each article was examined independently by at least 2 reviewers (KP, RT, PWN). The articles were selected based on consensus agreement between reviewers on the above criteria. The first screening

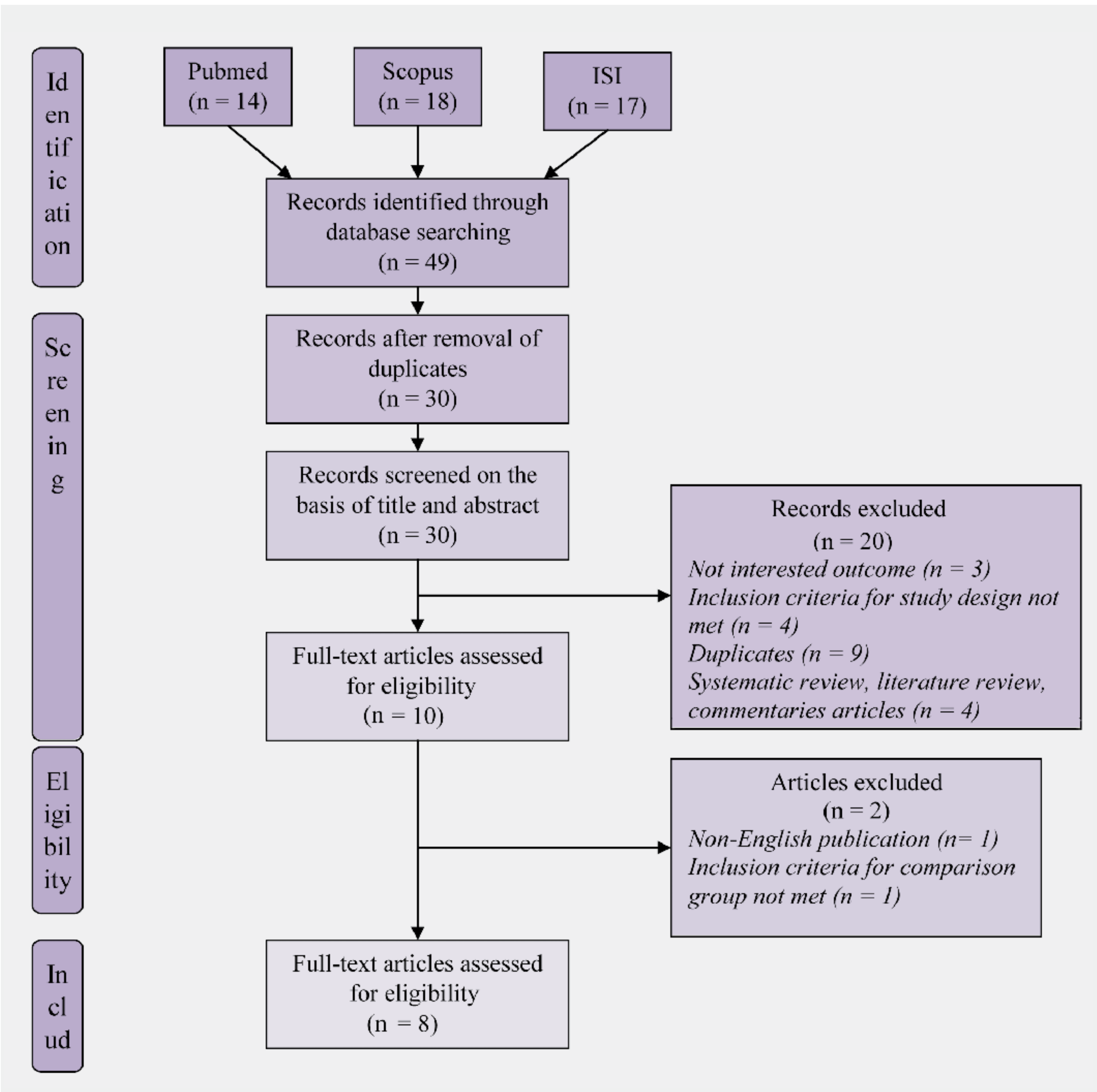


Fig 1. PRISMA flow diagram.

step was performed by reading through the title and abstract. If the reviewers could not decide on the study's eligibility by examining the title and the abstract, its full text was retrieved.

Data extraction

The data were extracted from each study independently by using tabular form (Table 2).

The information extracted was based on the following criteria:

1. Study design characteristics: the name of the first author, year of publication, and design of the study.
2. Participant characteristics: number of participants, gender of participants, mean age of participants
3. Interventions including: bracket type, sequence of arch wire used.
4. Outcome characteristics: type of scale used to record the pain intensity and time period taken to record the same, and results as interpreted.

Results

Description of studies

49 articles were identified from the electronic database search, 14 from PubMed, 18 from Scopus and 17 from Web of Science. 28 duplicated articles were removed by the Endnote program (Version X7, CA, USA) followed by manually double check. According to the inclusion and exclusion criteria, 10 full-text articles were retrieved after titles and abstract screening. The full texts were assessed, 2 of them were excluded due to the non-English publication and no comparison group in the study. Finally, 8 articles were included and evaluated in this systematic review (Fig 1.).

Six of eight included studies were RCT that the subject allocation was generated by randomization. All the studies measured pain or discomfort perception using the different method, visual analog scale (VAS), verbal rating scale (VRS) and a self-administered questionnaire associated with the oral health-related quality of life. VAS is the most frequently used among the studies.

Conventional bracket was compared to Damon self-ligating bracket in 5 studies[12-16] and SmartClip self-ligating bracket in 2 studies[17, 18]. Another study used 3 types of bracket: B, In-Ovation R (active self-ligating bracket, ASL), and Damon 3MX (passive self-ligating bracket, PSL) brackets[11].

Comparing the pain intensity between self-ligating and conventional bracket

In our finding from the 8 included studies, it was clear that there was variety with regard to the results. Two studies[12, 13] reported significant difference in favor of self-ligating brackets, while 2 studies[17, 18] showed statistically significant difference in favor of conventional, in which one of them had no clinical significant difference, however, the remaining 4 studies[11, 14-16] demonstrated no significant difference between self-ligating and conventional brackets.

Interestingly, Fleming et al[17] demonstrated that SmartClip showed more pain perception significantly during the insertion and removal of archwire than conventional brackets.

Author	Year	Design	Participants	Interventions		Arch wire	Tool	Time	Outcome	Result
				Conventional	SLB					
Scott et al [14]	2008	RCT	60 of 62 patients analyzed (30 males and 30 females) Mean age 16 years, 3 months	27t patients : 0.022 inch slot Roth prescription SynthesisTM	33 patients : 0.022 inch slot Damon3TM	0.014 Cu NiTi	100 mm VAS	At 4 hours, 24 hours, 3 days, and 1 week.	Perceived discomfort levels	No statistically significant differences between the two appliances
Fleming et al [17]	2009	RCT	T1: 48 of 66 patients analyzed (16 males, 32 females) Mean age 15.96 years T2: 51 of 66 patients analyzed (18 male, 33 females) Mean age 16.78 years	0.022 inch slot Victory T1: 22 patients T2: 25 patients	0.022 inch slot SmartClip T1: 26 patients T2: 26 patients	T1: 0.016 NiTi T2: 0.019 x 0.02 SS (removal and insertion)	100 mm VAS	At 4 hours, 24 hours, 3 days, and 1 week.	Pain Scores	T1: Bracket type had no influence on pain experience T2: Discomfort was experienced during archwire insertion and removal : SmartClip > Victory

Table 2. Characteristics of studies.

Author	Year	Design	Participants	Interventions		arch wire	Tools	Time	Outcome	Result
				Conventional	SLB					
Pringle et al[12]	2009	RCT	52 of 66 patients analyzed (24 males, 28 females) Mean age 15.68 years	28 patients with Tru Straight	24 patients with Damon 3	0.014 Cu NiTi	100 mm VAS	Twice a days over 7 days	Maximum pain intensity Mean pain intensity	Damon 3 < Tru Straight Damon 3 < Tru Straight
Tecco et al[13]	2009	CCT	30 patients (12 males, 18 females) Mean age 16.8 years	15 patients with 0.022 inch slot Victory Series	15 patients with t 0.022 inch slot Damon SL II	0.014 NiTi	100 mm VAS	Daily, 3 months	Pain intensity	Damon < Victory Series (SLB : chewing/ biting pain, CLB : constant pain)
Atik and Ciger[15]	2014	RCT	33 patients (all females) Mean age: 14.65 years	17 patients with 0.022 inch slot Roth prescription Forestadent	16 patients with 0.022 inch slot Damon 3MX	0.014 Cu NiTi	100 mm VAS	At 4 hours, 24 hours, 3 days, 1 week, and 1 month	Perceived discomfort levels	No significant differences between the two appliances

Table 2. Continued

Author	Year	Design	Participants	Interventions		arch wire	Tools	Time	Outcome	Result
				Conventional	SLB					
Othman et al	2014	RCT	60 patients (29 males, 31 females) Mean age 18.3 years	8 patients with Victory	9 patients with In-Ovation R (ASL) and 12 patients with Damon 3MX (PSL)	0.014 Cu NiTi 0.016 Cu NiTi 0.018 Cu NiTi 0.016 x 0.022 Cu NiTi 0.016 x 0.025 Cu NiTi	Modified 16-item Malaysian version of the Oral Health Impact Profile	Conventio-nal : every 4 weeks ASL : every 6 weeks PSL : every 8 weeks	Physical pain	Significant differences was noted at the late assessment of the second activation phase, with the PSL group showing the highest values.
Zhou et al	2014	CCT	150 patients (58 males, 92 females) Age range 13-18 years	75 patients with 0.022 x 0.030 inch slot 3M Unitek	75 patients with 0.022 x 0.027 inch slot Damon 3	0.012 NiTi 0.014 NiTi 0.016 NiTi 0.019 x 0.025 NiTi 0.019 x 0.025 SS	The 14-item Oral Health Impact Profile (OHIP-14, Chinese version)	1week (T1), 1month (T2), 3months (T3), 6months (T4); and after treatment (T5)	Physical Pain	Bracket type had no effect on pain experience

Table 2. Continued

Author	Year	Design	Participants	Interventions		arch wire	Tools	Time	Outcome	Result
				Conventional	SLB					
Shahla Rahman et al	2015	RCT	113 of 138 patients analyzed (41 males, 72 female Mean age: 14 years 9 months	60 patients with Victory	53 patients with SmartClip	**Victory** 0.014 NiTi 0.018 NiTi 0.019x0.025 NiTi 0.019x0.025 SS **SmartClip** 0.014 NiTi 0.016x0.025 NiTi 0.019x0.025 NiTi 0.019x0.025 SS	VRS of none, mild, moderate and severe	at day 1, day 3, and day 5 following the appointment	Pain perception	SmartClip > Victory (statistically significant differences) No clinically significant difference between the two appliances

Table 2. Continued RCT: Randomized controlled clinical trial, CCT: controlled clinical trial, VAS: Visual analog scale, VRS: Verbal rating scale, ASL: Active self-ligating, PSL: Passive self-ligating, NiTi: Nickel Titanium, SS: Stainless Steel.

Overall pain experience at each time interval

Different levels of discomfort and pain were reported at different time interval that varied in each study with the use of single arch wire and sequence of arch wires among the two bracket systems.

Most of the articles reported the critical pain perception occurred during the first seven days after the placement of the arch wire regardless of the bracket types. The peak in pain intensity obtained within the first 24 hours, thereafter, it decreased significantly until the third day which was followed by a gradually decrease till the seventh day.

There were two articles [12, 13] which found statistically significant difference in level of pain at every time interval in terms of bracket type, on the other hand, two articles [15, 17]reported no statistically significant difference in level of pain among the two bracket types with regard to time interval. Scott et al [14] found no statistically significant difference during the first day, however, statistically significant difference were found to arise starting from the third until the seventh day. The statistical data from Rahmans' study [18] was not available with regard to bracket type compared to time interval. Zhou et al [16] presented no statistically significant difference in pain experience only at seventh day; however, there was no information available for the first and the third day. Another article by Othman et al [11] did not provide the data on our interested time period.

Discussion

Self-ligating brackets were claimed to deliver less discomfort and pain. Pringle [12] suggested that this could be due to the method of ligation used that allowed the archwire to pass through adjacent brackets without being forced against the slot base.

To test such claims in evidence-based medicine, the criteria must be strictly employed to lessen as much biases as possible. According to several studies, pain experienced during archwire application were varied at different site in oral region. Pain was perceived more anteriorly than posteriorly [19, 20] and maxillary than mandibular [21] that is why the split-mouth design was excluded from the review, because, it could result in inaccuracy of the reported pain.

How the pain was measured was an essential part of the evaluation. Various methods had been suggested as an effective tool to evaluate pain perception, which included visual analog scale (VAS) [22], numerical rating scale (NRS) [23], verbal rating scale (VRS) [24], and McGill pain questionnaire (MPQ) [25], although the latter had not been widely explored in orthodontics.

One of the most frequently used methods to measure and evaluate pain is VAS [12-15, 17] which was a unidimensional scale. It allows patient to mark a location on the line relating to the level of pain or discomfort. The advantages of VAS are easy to use, no need on verbal or reading skill, can be used in a variety of settings, freedom of choice to choose the pain intensity, providing a smooth continuous of pain intensity and high compliance rates [22, 23, 26]. Although, the small differences of VAS score can be identified as statistically significant, the minimum clinically significant difference VAS score is 13 mm [22]. On the other hand, there were also some reports on higher number of errors with increasing age and other impairments making VAS less applicable in the cognitively impaired [27, 28]. VRS scale has been widely used to evaluate pain intensity; unfortunately, it does not gain much attention in orthodontics. The process required patients to choose provided term, ranging from "No Pain" to "Worst Pain Imaginable", that suit their pain levels. Generally, 4 to 7 response categories were used and considered to be equally effective as VAS.

In addition to these standard scales, oral health-related quality of life (OHRQoL) [29], which is a multidimensional construct that assesses various aspects of subjective evaluations, including "Physical pain" domain, may be another tool to evaluate pain intensity. However, due to its recent emergence, one may question validity of the method on reporting pain intensity.

However, some types of pain are complex (such as, cancer pain, osteoarthritis pain, or pain causing from TMD) and require a multidimensional assessment to evaluate the pain experience, instead of, VAS and NRS, which are both unidimensional scale. One might be questioned whether patients with orthodontic treatment are able to discriminate between pain and other factors, such as ulceration and irritation created from the sharp portion of the brackets themselves that interfere with their function.

Three studies [12, 14, 18] discussed the relationship between age, gender and pain perception that showed no statistically significant relationship among those factors by patients treated with orthodontic fixed appliance.

This insignificant effect of gender corresponded with some previous studies [24, 30]. In contrast, other studies found that, women reported higher discomfort or pain levels than men [20, 31, 32].

No statistically significant between age and pain was reported in previous study [30]. On the other hand, there were some conflicting conclusions of correlation between age and pain perception; several studies found significant correlation with adult perceiving higher pain than adolescents [21, 24]. Moreover, other study found that adolescents reported a higher level of pain than pre-adolescents and adults [33].

Most studies presented that the pain was perceived after 4 hours of initial archwire placement and reached the peak of discomfort at 24 hours. Then the pain significantly decreased for 2-3 days and further gradually decreased until returning to normal by 5-7 days [14, 15, 17, 18, 34]. This finding showed the same direction with numerous previous investigations [20, 21, 24, 35-38].

Since presented malocclusion of each samples and initial archwires placement were diverse, the force activated would vary between each individual sample which theoretically should affect the level of pain. However, studies comparing various archwires to determine differences in pain perception showed no statistically significant results. No difference in the intensity, prevalence, or duration of pain between different archwires was found [19, 21, 38]. Recent study by Abdelrahman et al [39], which was in agreement with previous studies, showed that there were no significant differences in pain perception in terms of incisor irregularity and three different formed of NiTi archwires inserted.

In terms of biological response, Yamaguchi et al [40] reported that the Damon bracket, comparing to the conventional bracket at 24 hours, showed significantly less amount of released substance P (SP), one of the inflammatory mediator involved with orthodontic tooth movement; however, there was no significant difference at 1 and 168 hours. This finding may support the idea that self-ligating brackets are advantageous in reducing inflammation and pain. Based on this ground, there seem to be a controversy, in both between pain intensity study themselves and between pain intensity and inflammatory marker.

Conclusion

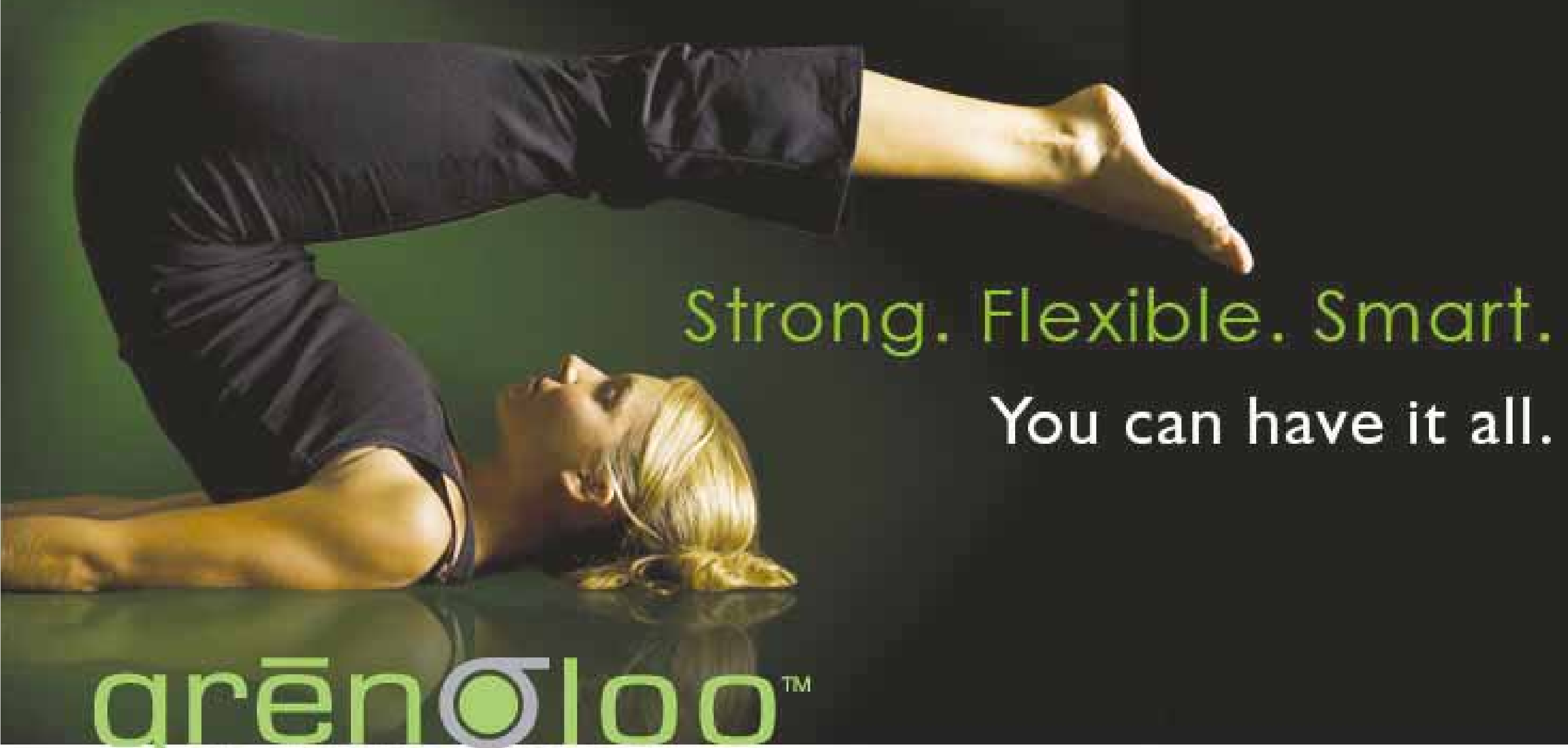
There seems to be conflicting results in pain experiences from self-ligating and conventional brackets and, above all, those published results were faced with difficulty explaining the overall perceived pain from different orthodontic brackets. Further well-designed studies are required for an appropriate conclusion regarding this issue. Studies based on biologic response might provide some insights and better precision according to the exacerbated pain, although these markers may not truly reflect perceived pain.

References

1. Harradine NW. Self-ligating brackets and treatment efficiency. **Clin Orthod Res**. 2001;4(4):220-7.
2. Eberting JJ, Straja SR, Tuncay OC. Treatment time, outcome, and patient satisfaction comparisons of Damon and conventional brackets. **Clin Orthod Res**. 2001;4(4):228-34.
3. Bos A, Hoogstraten J, Prahl-Andersen B. Towards a comprehensive model for the study of compliance in orthodontics. **Eur J Orthod**. 2005;27(3):296-301.
4. Patel V. Non-completion of active orthodontic treatment. **Br J Orthod**. 1992;19(1):47-54.
5. Sergl HG, Klages U, Zentner A. Functional and social discomfort during orthodontic treatment effects on compliance and prediction of patients' adaptation by personality variables. **Eur J Orthod**. 2000;22(3):307-15.
6. Pithon MM, dos Santos RL, Nascimento LE, Ayres AO, Alviano D, Bolognese AM. Do self-ligating brackets favor greater bacterial aggregation? **Braz J Oral Sci**. 2011;10(3):208-12.
7. Polat O, Gökçelik A, Arman A, Arhun N. A comparison of white spot lesion formation between a self-ligating bracket and a conventional preadjusted straight wire bracket. **World J Orthod**. 2008;9(2):e46-50.
8. Zhu YL. Tolerance comparison between patients with self-ligating brackets and conventional straight wire brackets during initial alignment. **J Clin Rehab Tissue Eng Res**. 2009;13(25):4893-6.
9. Bertl MH, Onodera K, Čelar AG. A prospective randomized split-mouth study on pain experience during chairside archwire manipulation in self-ligating and conventional brackets. **Angle Orthod**. 2013;83(2):292-7.
10. Do Nascimento LEAG, Pithon MM, Dos Santos RL, Ayres Freitas AO, Sales Alviano D, Nojima LI, et al. Colonization of Streptococcus mutans on esthetic brackets: Self-ligating vs conventional. **Am J Orthod Dentofacial Orthop**. 2013;143(4 SUPPL):S72-7.
11. Othman SA, Mansor N, Saub R. Randomized controlled clinical trial of oral health-related quality of life in patients wearing conventional and self-ligating brackets. **Korean J Orthod**. 2014;44(4):168-76.
12. Pringle AM, Petrie A, Cunningham SJ, McKnight M. Prospective randomized clinical trial to compare pain levels associated with 2 orthodontic fixed bracket systems. **Am J Orthod Dentofacial Orthop**. 2009;136(2):160-7.
13. Tecco S, D'Attilio M, Tete S, Festa F. Prevalence and type of pain during conventional and self-ligating orthodontic treatment. **Eur J Orthod**. 2009;31(4):380-4.
14. Scott P, Sherriff M, Dibiase AT, Cobourne MT. Perception of discomfort during initial orthodontic tooth alignment using a self-ligating or conventional bracket system: a randomized clinical trial. **Eur J Orthod**. 2008;30(3):227-32.
15. Atik E, Ciger S. An assessment of conventional and self-ligating brackets in Class I maxillary constriction patients. **Angle Orthod**. 2014;84(4):615-22.
16. Zhou Y, Zheng M, Lin J, Wang Y, Ni ZY. Self-Ligating Brackets and Their Impact on Oral Health-Related Quality of Life in Chinese Adolescence Patients: A Longitudinal Prospective Study. **Sci World J**. 2014. Article ID 352031. Available on http://dx.doi.org/10.1155/2014/352031.
17. Fleming PS, Dibiase AT, Sarri G, Lee RT. Pain experience during initial alignment with a self-ligating and a conventional fixed orthodontic appliance system. A randomized controlled clinical trial. **Angle Orthod**. 2009;79:46-50.
18. Rahman S, Spencer RJ, Littlewood SJ, O'Dywer L, Barber SK, Russell JS. A multicenter randomized controlled trial to compare a self-ligating bracket with a conventional

bracket in a UK population: Part 2: Pain perception. **Angle Orthod**. 2016 ; 86:149-56

19. Erdinc AM, Dincer B. Perception of pain during orthodontic treatment with fixed appliances. **Eur J Orthod**. 2004;26(1):79-85.
20. Scheurer PA, Firestone AR, Burgin WB. Perception of pain as a result of orthodontic treatment with fixed appliances. **Eur J Orthod**. 1996;18(4):349-57.
21. Fernandes LM, Ogaard B, Skoglund L. Pain and discomfort experienced after placement of a conventional or a superelastic NiTi aligning archwire. A randomized clinical trial. **J Orofac Orthop**. 1998;59(6):331-9.
22. Gallagher EJ, Liebman M, Bijur PE. Prospective validation of clinically important changes in pain severity measured on a visual analog scale. **Ann Emerg Med**. 2001;38(6): 633-8.
23. Hjermstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for assessment of pain intensity in adults: a systematic literature review. **J Pain Symptom Manage**. 2011;41(6):1073-93.
24. Jones M, Chan C. The pain and discomfort experienced during orthodontic treatment: a randomized controlled clinical trial of two initial aligning arch wires. **Am J Orthod Dentofacial Orthop**. 1992;102(4):373-81.
25. Iwasaki LR, Freytag LE, Schumacher CA, Walker MP, Williams KB. Validation of a modified McGill Pain Questionnaire for orthodontic patients. **Angle Orthod**. 2013;83(5):906-12.
26. Krishnan V. Orthodontic pain: from causes to management--a review. **Eur J Orthod**. 2007;29(2):170-9.27. Jensen MP. The validity and reliability of pain measures in adults with cancer. **J Pain**. 2003;4(1):2-21.
28. Caraceni A, Cherny N, Fainsinger R, Kaasa S, Poulain P, Radbruch L, et al. Pain measurement tools and methods in clinical research in palliative care: recommendations of an Expert Working Group of the European Association of Palliative Care. **J Pain Symptom Manage**. 2002;23(3): 239-55.
29. Rusanen J, Silvola AS, Tolvanen M, Pirttiniemi P, Lahti S, Sipila K. Pathways between temporomandibular disorders, occlusal characteristics, facial pain, and oral health-related quality of life among patients with severe malocclusion. **Eur J Orthod**. 2012;34(4):512-7.
30. Ngan P, Kess B, Wilson S. Perception of discomfort by patients undergoing orthodontic treatment. **Am J Orthod Dentofacial Orthop**. 1989;96(1):47-53.
31. Bergius M, Kiliaridis S, Berggren U. Pain in orthodontics. A review and discussion of the literature. **J Orofac Orthop**. 2000;61(2):125-37.
32. Kvam E, Gjerdet NR, Bondevik O. Traumatic ulcers and pain during orthodontic treatment. **Community Dent Oral Epidemiol**. 1987;15(2):104-7.
33. Brown DF, Moerenhout RG. The pain experience and psychological adjustment to orthodontic treatment of preadolescents, adolescents, and adults. **Am J Orthod Dentofacial Orthop**. 1991;100(4):349-56.
34. Fleming PS, Johal A. Self-ligating brackets in orthodontics. A systematic review. **Angle Orthod**. 2010;80(3):575-84.
35. Polat O, Karaman AI. Pain control during fixed orthodontic appliance therapy. **Angle Orthod**. 2005;75(2):214-9.
36. Firestone AR, Scheurer PA, Burgin WB. Patients' anticipation of pain and pain-related side effects, and their perception of pain as a result of orthodontic treatment with fixed appliances. **Eur J Orthod**. 1999;21(4):387-96.
37. Wilson S, Ngan P, Kess B. Time course of the discomfort in young patients undergoing orthodontic treatment. **Pediatr Dent**. 1989;11(2):107-10.
38. Jones ML. An investigation into the initial discomfort caused by placement of an archwire. **Eur J Orthod**. 1984;6(1):48-54.
39. Abdelrahman RS, Al-Nimri KS, Al Maaitah EF. Pain experience during initial alignment with three types of nickel-titanium archwires: A prospective clinical trial. **Angle Orthod**. 2015. doi: http://dx.doi.org/10.2319/071614498.1.
40. Yamaguchi M, Takizawa T, Nakajima R, Imamura R, Kasai K. The Damon System and release of substance P in gingival crevicular fluid during orthodontic tooth movement in adults. **World J Orthod**. 2009;10(2):141-6.



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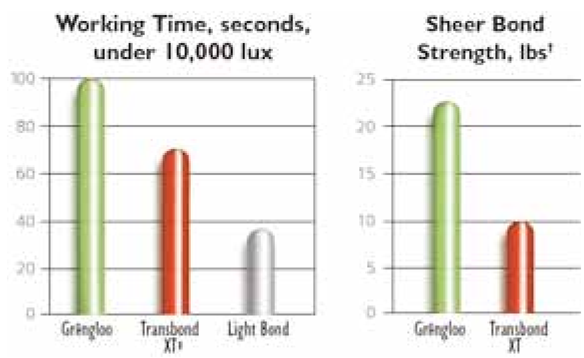

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