**Republic of Iraq**
**Ministry of Higher Education and Scientific Research**
**University of Baghdad**
**College of Dentistry**

# 2×4 Appliances

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Orthodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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# Certification of the Supervisor

I certify that this project entitled **"2×4 appliances"** was prepared by **Reham Ali Abd Al-Ridha** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor degree in dentistry.

**Professor**

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**B.D.S., M.Sc., Ph.D.**

**The supervisor**

**10-5-2023**

# DEDICATION

***I dedicate this project to***

***My great parents, who never stop giving of themselves in countless ways,***

***My brothers and sister, who always stand with me,***

***My friends, who stand by me when things look bleak,***

***My supervisor, who has been a constant source of support and encouragement,***

***And to all people in my life who touched my heart.***

*Reham*

# Acknowledgment

First, I thank "**Allah**" almighty for granting me the will and strength to accomplish this project and I pray that his blessings upon me may continue throughout my life.

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# List of Abbreviations

| | |
|---|---|
| e.g. | exempli gratia (for example) |
| et al. | et alia (and others) |
| etc | et cetera (and so forth) |
| g | Gram |
| mm. | Millimeter |
| NiTi | Nickel Titanium |

# Introduction

Mixed dentition stage is a period of transition from primary teeth to permanent teeth. Due to this transition the differences between a malocclusion requiring correction with those which are self-correcting needs to be emphasized. Few of the most common malocclusions seen during this stage are the anterior and posterior crossbites, crowding, rotations, midline diastema, spacing, etc. **(Foster, 1990)**.

Interceptive treatment is fundamental to reduce the severity of a developing malocclusion. For example, cross bites should be intercepted and treated at an early stage because it is a self-perpetuating condition which if not treated early has the potential of growing into skeletal malocclusion and might at a later stage require major orthodontic treatment combined with surgical procedures. Interceptive orthodontic treatment at an early stage can not only boost the young child's self-esteem but also avoid the need of undergoing cumbersome orthodontic treatment in the future **(Graber and Vanarsdall, 2000)**.

Treating simple cases may entail using removable or fixed appliances. Bonding fixed appliance on primary teeth may not be feasible, so the 2×4 fixed appliance is used instead. It consists of bands on the first permanent molars, brackets bonded to the erupted maxillary incisors and continuous archwires to provide/maintain good arch form, as well as control of anterior teeth. It offers more effective and efficient tooth positioning as it allows three-dimensional control of the involved teeth during correction of anterior crossbites or aligning ectopic incisors. Rotations, diastemas and incorrect tooth inclinations and angulations may therefore be treated very quickly using this versatile appliance. This appliance does not only quickly restore anterior esthetics but it may also reduce the complexity and duration of any subsequent treatment **(Mckeown and Sandler, 2001)**.

## Aims of the study

This study aims to review the various types of the 2×4 appliances used in daily orthodontic practice, their advantages, disadvantages, modifications and the biomechanics for each use.

# Chapter One

# Review of Literature

## 1.1 Fixed orthodontic appliance

It is an orthodontic device that can not be removed or adjusted by the patient. It consists of attachments fixed on to the teeth surface, transmitted the force applied by archwires and/or other auxiliaries to the teeth **(Singh, 2015)**.

### 1.1.1 Indications of fixed orthodontic appliance

Fixed orthodontic appliance is indicated to treat variety of cases requiring multiple tooth movement like intrusion, extrusion, derotation, translation, and torquing movement in addition to controlled space closure that can not be achieved by other appliances **(Littlewood and Mitchell, 2019)**.

### 1.1.2 Contraindications of fixed orthodontic appliance

**Singh (2015) and Phulari (2017)** listed down the following contraindications:

1. Poor patient's motivation.
2. Poor dental and/or periodontal health patients.
3. Severe skeletal discrepancies beyond the scope of this appliance.
4. Inappropriately trained or inexperienced operator.

### 1.1.3 Advantages of fixed orthodontic appliance

**Phulari (2017)** summarized the advantages of this appliance as followed:

1. No problem in the retention of the appliance as it is bonded/cemented to the teeth.
2. It requires less skill and efforts from the patient in managing the appliance other than caring and cleaning.
3. Multiple tooth movements can be achieved at the same time.

### 1.1.4 Disadvantages of fixed orthodontic appliance

**Singh (2015) and Phulari (2017)** summarized the disadvantages of this appliance as followed:

1. Oral hygiene issue.
2. Damaging of the teeth and supporting structures by excessive force.
3. Adverse tooth movements are possible.
4. It can affect esthetics.
5. Needs well-trained operator.
6. Costly in comparison with the removable appliance.
7. Increased chair side time.
8. Anchorage control is not as easy as the removable appliance.
9. Long treatment time.

### 1.1.5 Components of fixed orthodontic appliance

Fixed orthodontic appliance broadly consists of active and passive components. The passive components are not force generating parts but help provide attachment for other auxiliaries to the teeth and included **(Phulari, 2017)**:

1. Attachments; bands, brackets, lingual button, lingual sheath, lingual cleat, eyelet.
2. Ligature wire
3. Lock pins

The active components are used to generate forces that cause tooth movement and included **(Singh, 2015; Phulari, 2017)**:

1. Separators; elastic separator and brass wire separator.
2. Archwires; gold, stainless steel, Nitinol, Beta Titanium, and multi-stranded.
3. Springs; uprighteing, torquing, rotation, open coil, closed coil spring.

4. Elastic modules; intra-oral and extra-oral elastic bands, elastic chain, elastic thread, elastic ligature.
5. Magnets.

## 1.2 The 2×4 appliance

### 1.2.1 Definition

This fixed appliance comprises bands/ buccal tubes on the first permanent molars, brackets on the erupted maxillary permanent incisors, and archwire **(Dowsing and Sandler, 2004)**. Continuous archwires are used to provide complete control of the anterior dentition as well as a good arch form (Figure 1).

**Figure 1.** The components of 2×4 appliance. Brackets on the anterior teeth, bands on the molars, archwire and supporting metal tube **(Dowsing and Sandler, 2004)**

### 1.2.2 Advantages of 2×4 appliance

1. It provides effective control over the anterior dentition-tooth movement in three dimensions (translation, tipping, torque, and rotations) and to maintain the adequate arch form **(Rohilla *et al.*, 2017; Solanki *et al.*, 2017)**.
2. The appliance is easy to apply, versatile and allows a fast and more predictable outcome in a single short phase **(Dowsing and Sandler, 2004)**.
3. This appliance is well-tolerated and does not require any adjustment by the patient or parents **(Singhal et al., 2015)**.
4. It can be modified, e.g., wire loops can be added for the support of inter or intra-maxillary elastics (especially useful for the traction of ectopic or

impacted permanent upper canines, at later ages), or open-coil springs for the creation of space in the dental arch **(Rodríguez *et al.*, 2023)**.

5. The 2×4 appliance can be carried out at a single visit **(Dowsing and Sandler, 2004; Subramanyam, 2019)**.
6. No laboratory facilities are involved **(Agarwal and Mathur, 2011; Rohilla *et al.*, 2017, Soni *et al.*, 2019)**.
7. The patient's normal speech is not affected **(Yordanova *et al.*, 2016)**.
8. Improving patient's appearance, psychosocial status, and enhance self-perception/esteem by reducing teasing and bullying **(Subramanyam, 2019)**.

### 1.2.3 Disadvantages of 2×4 appliance

**Dowsing and Sandler (2004), Naidu and Suresh (2018), Sockalingam *et al.*, (2018), Subramanyam (2019), Shrimahalakshmi *et al.* (2023), and Rodríguez *et al.* (2023)** listed down the following disadvantages:

1. The patient may need a second phase of orthodontic treatment in the future.
2. Limited anchorage.
3. The distally extended archwire behind the molars tubes can be dislodged during eating or brushing.
4. The technique can not correct skeletal malocclusions or abnormal intermaxillary relationships.
5. This appliance is unable to modify inadequate oral muscle patterns, unlike orthopedic removable appliances.
6. It is unsuitable for primary dentition.
7. It requires more chair-side time to fit (including enamel etching and bracket bonding) in comparison with the removable appliance.
8. White spot lesions and caries may develop with poor oral hygiene.

9. Placement of the molar band could be a problem if the permanent molar has not fully erupted or it has a short clinical crown height.
10. Placement of the band can cause discomfort, and some children may refuse further treatment.

### 1.2.4 Indications of 2×4 appliance

**Isaacson and Rebellato (1995), Dowsing and Sandler (2004), Naidu and Suresh (2018), and Rodríguez *et al.* (2023)** summarized the main indications of 2×4 appliances as followed:

1. Management of anterior/posterior crossbites.
2. Correction of ectopic or impacted upper permanent central incisors.
3. Closure of midline diastemas or abnormal spacing.
4. Alignment of anterior crowding and mild rotation.
5. Vertical control of the anterior teeth for deep bite/ open bite correction.
6. Applying torquing on the anterior teeth.

#### 1.2.4.1 Management of anterior/ posterior crossbites

Anterior crossbite is usually a major functional and esthetic issue during the early stages of oral development in children **(Bishara, 2001)**. There is an old orthodontic maxim: "the best time to treat a crossbite is the first time it is seen" **(Bhalajhi, 2006; Sunil *et al.*, 2017)**. Early management of anterior crossbites has been strongly recommended for avoiding the possible progress of the condition to a true class III malocclusion in the future **(Wiedel and Bondemark, 2015; Yordanova *et al.*, 2016)**.

The 2×4 appliance is frequently employed for the correction of crossbites in the mixed dentition as it allows the protrusion of upper incisors **(Yordanova *et al.*, 2016)**. It is mandatory to eliminate the premature contacts between opposite teeth in cases of functional crossbites **(Sockalingam *et al.*, 2018; Soni *et al.*, 2019)**.

The appliance has a great power of action and can provide lighter continuous forces for resolving anterior crossbites when compared to conventional removable devices **(Sunil *et al.*, 2017; Naidu and Suresh, 2018)**, therefore; it can achieve excellent results in a short time of therapy **(Agarwal and Mathur, 2011; Wiedel and Bondemark, 2015; Rohilla *et al.*, 2017)**. The treatment involving placement of consecutive straight NiTi and stainless steel archwire with bite opening **(Dowsing and Sandler, 2004; Reyes *et al.*, 2014)**, as shown in figure 2.

**Figure 2.** Management of anterior cross bite of the maxillary incisors using 2×4 appliance and bite plane. The left photo is before treatment and the right photo is during treatment **(Reyes *et al.*, 2014)**

Another way is by initiating teeth alignment with NiTi then placing stainless steel archwire of 0.016 or 0.018-inch with omega loops in front of the first molars that will be activated to procline the anterior teeth **(Yanez, 2008; Proffit *et al.*, 2019)** as shown in figure 3.

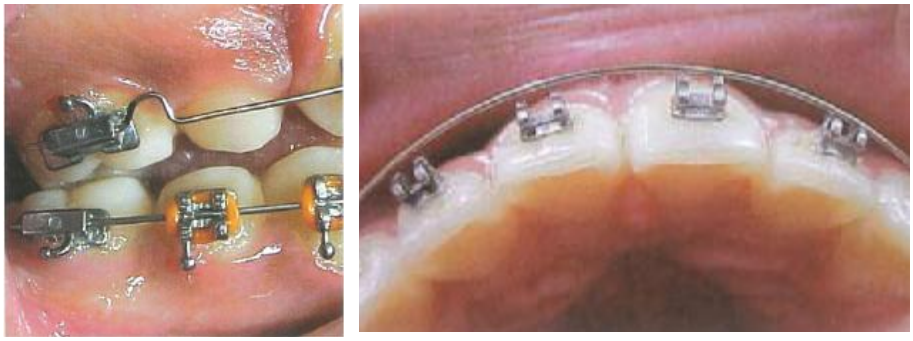

**Figure 3.** Management of anterior cross bite of the maxillary incisors using 2×4 appliance. The photo in the left side shows the omega loop in front of the first molar. The photo in the right shows the active form of the wire **(Yanez, 2008)**

Bilateral omega loop or helices may be placed also just distal to the lateral incisors and the activation is the same by pulling the wire so it will be about 1-2mm in front of the incisors brackets then it will be enforced to be seated in the slots and ligated by ligature elastics **(Takane *et al.*, 2019; Brito *et al.*, 2020)** and this clear in figure 4.

**Figure 4.** Treatment of anterior cross bite with 2×4 appliance. A 0.017×0.025-inch beta Titanium archwire with bilateral helices in addition to bonded hyrax **(Takane *et al.*, 2019)** in the left photo or posterior bite plane **(Brito *et al.*, 2020)** in the right photo.

If additional space is required for incisor proclination, a compressed NiTi push coil spring can be inserted between the molars and incisors or into a 2–3 mm gap between the steel or plastic tube and the incisors **(Buitrago and Saavedra, 2015)**. Moreover class III elastics can be run with 2×4 appliance to procline the maxillary anteriors and retroclined the mandibular anterior teeth help correct the anterior crossbite **(Alami *et al.*, 2015)** as shown in figure 5.

**Figure 5.** Treatment of anterior cross bite with 2×4 appliance and active NiTi push coil spring on the left side **(Buitrago and Saavedra, 2015**), or using class III elastics **(Alami *et al.*, 2015)** on the right side.

In cases of posterior crossbites, when maxillary expansion is indicated, a quadhelix can be added to the 2×4 appliance (Figure 6). It can be soldered to

molar bands or palatal sheaths welded for provision a removable quadhelix if correction of a posterior crossbite is required simultaneously **(Dowsing and Sandler, 2004; Loli, 2017)**.

**Figure 6.** Management of anterior and posterior cross bites using 2×4 appliance. The left photo is before treatment, the middle photo is during treatment showing the 2×4 appliance and the quadhelix, the right photo is after treatment completion **(Dowsing and Sandler, 2004)**

### 1.2.4.2 Ectopic/impacted upper permanent central incisors

Another indication of the 2×4 appliance at an early stage is the correction of ectopic or impacted permanent incisors. Once the etiological factor has been identified, it may be that the necessary space to be created to allow the adequate reposition of the affected tooth and bring it into its correct site in the dental arch **(Dowsing and Sandler, 2004)**.

The 2×4 appliance can easily perform a careful space opening and also control the traction force magnitude and vector, with much more precision than with removable appliances **(Loli, 2017)**. In this respect, **Das and co-workers (2020)** have established the determining factors to take on account for the successful alignment of an impacted incisor with the appliance: the position and direction of the impacted tooth, the degree of root dilacerations, the degree of root development, and the presence of sufficient space for the impacted incisor.

After adequate space creation and just before incisor traction, heavy gauge stainless steel archwire was placed with push coil spring to maintain the arch form and the space for the impacted incisor. Traction can be done either with

elastomeric chain, ligature wire, and auxiliary archwire or piggy back **(Dowsing and Sandler, 2004)** as shown in figure 7.

**Figure 7.** Management of impacted maxillary left central incisor using 2×4 appliance. The left photo is before treatment, the middle photo is during treatment showing traction of the impacted tooth with piggy-back technique, the right photo is after treatment completion **(Dowsing and Sandler, 2004)**

### 1.2.4.3 Closure of midline diastemas or abnormal spacing

Once eliminated the local etiological factor for the diastema, a sectional 2×4 appliance can be placed for achieving a better controlled space closure and the alignment and leveling of the upper incisors. Sometimes, closing loop wire, inter-brackets elastomeric chains, push coil spring, and micromagnetic devices are added to facilitate the space closure as shown in figure 8 **(Yanez, 2008; Hussain *et al.*, 2013)**.

**Figure 8.** Closure of anterior spaces and median diastema using power chain and push coil as shown in the left photo or closing loop wire as shown in the right photo **(Yanez, 2008; Bennett and McLaughlin, 2014).**

The orthodontic midline diastema closure in mixed dentition has been classified into four categories **(Garrocho-Rangel *et al.*, 2016)**: treatment

involving mesial tipping of incisors for the approximation of spaced tooth crowns only, treatment involving mesial bodily movements for the approximation of both central incisors, treatment involving a decrease of enlarged overbite and intrusion of the upper incisors, and closure of the space as part of a more comprehensive orthodontic treatment.

The choice of treatment option depends on the angulation of the incisor, ugly duckling stage, amount of overjet and overbite. Care should be taken regarding the erupting maxillary canines in order to prevent the problem of root resorption during space closure, so to prevent this problem, swabbing the brackets of the lateral incisors to get mesial movement of the roots is indicated **(Fleming and Seehra, 2019).**

Closure of anterior spacing with minimal or negative overjet by elastomeric chain will worsen the case, so push coil spring (that extends from the lateral incisors brackets and molar bands or between the lateral incisor brackets and a metal or plastic sheet) is indicated, conversely, with increased overjet, the power chain will be a good option for space closure. Double-helical loops incorporating in the steel or beta Titanium archwire of 0.017×0.025-inch with or without step is suited to treat cases with spacing, increased overjet and/or increased overbite **(Yanez, 2008)**.

### 1.2.4.4 Alignment of anterior crowding and mild rotation

Some cases of mild anterior crowding and rotation can be solved using 2×4 appliance with consecutive NiTi then stainless archwires (Figure 9). Some cases might need interproximal enamel reduction in addition to this appliance. Exerting the light force is the key factor in correcting such type of malocclusion **(Dowsing and Sandler, 2004)**.

**Figure 9.** Management of irregular and rotated incisors using 2×4 appliance. The left photo is before treatment, the middle photo is during treatment, and the right photo is after treatment completion **(Dowsing and Sandler, 2004)**

### 1.2.4.5 Vertical control of the anterior teeth for deep bite/ open bite correction

Anterior teeth can be controlled vertically by 2×4 appliances called utility arch, continuous intrusion arch and Connecticut intrusion arch (**Pokharel and Shrestha, 2023)**.

### A. The utility arch

It was developed by Dr. Robert Ricketts in early 1950s and fabricated from 0.016×0.016 or 0.016×0.022-inch Blue Elgiloy wire (chrome-cobalt wire that is manipulated easily and loops can be formed in the wire with little difficulty) in order to create a lever system that will deliver a continuous force to the incisors. Regardless of the presence or absence of loops, all utility arches have common design which consists of **(Bench *et al.*, 1978; McNamara, 1986)**: the molar segments, posterior vertical segment, vestibular segment, anterior vertical segment, and incisal segment (Figure 10).

**Figure 10:** Utility arch **(Yanez, 2008)**

It is activated by placing a tip-back and toe-in bends (or cinching back the end of the wire) in the molar segment or by placing an occlusally directed gable bend in the posterior aspect of the vestibular segment. Engaging the utility arch will produce approximately 50-75g on all anterior teeth. This force level is considered ideal for incisor intrusion. The overall effect is an intrusion and possible torquing of the lower incisors, as well as a tipping back of the lower molars. In low angle cases, distal tipping of the molar will open the bite and aid in addition to the lower incisors intrusion in correcting the deep bite. As the wire engage the incisor brackets, a labial crown torque will be applied through the activated utility arch as the force is exerted anterior to the center of resistance (Figure 11). This will be beneficial in case of retruded lower incisors but not desired with proclined incisors so compensating lingual crown torque should be incorporated in the archwire to counteract this side effect. Molar rotation and expansion or contraction of molar width can be achieved by activating the molar section of the arch **(Proffit *et al.*, 2019)**.

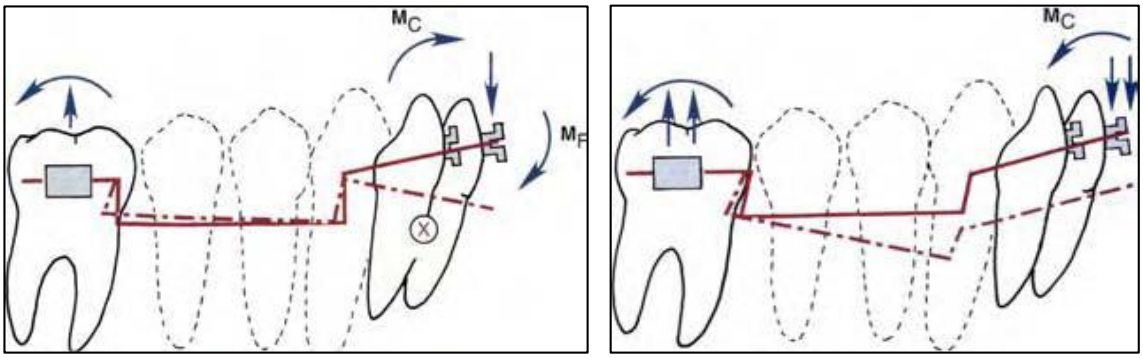


**Figure 11.** Activation of the utility arch will cause distal crown tipping and extrusion of the first molar and intrusion of the mandibular anterior teeth with proclination (left photo). To overcome this proclination either bend the wire behind the last molar or apply lingual crown torque on the mandibular anterior teeth **(Proffit *et al.*, 2019).**

Modifications of the utility arch are also quite beneficial in advancing or retracting the lower incisors (Figure 12). By simply incorporating loop systems into the basic utility arch, its function can be greatly enhanced as a force

delivery system which defines movement of the incisors and molars in all planes of space **(McNamara, 1986)**.

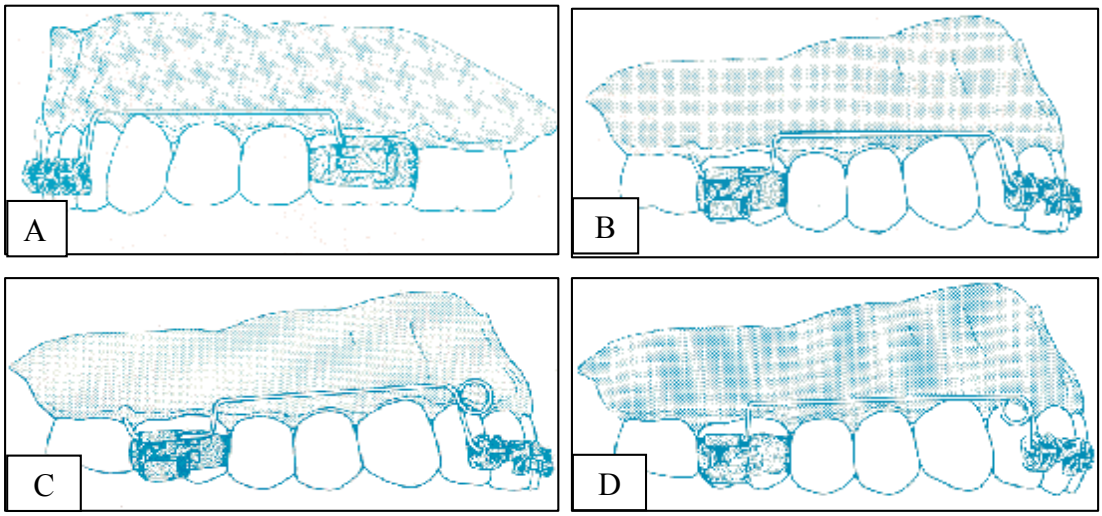


**Figure 12:** Types of utility arch. A. Passive utility arch with posterior vertical step fitting snugly against the auxiliary tube of the maxillary first molar, B. Intrusion utility arch with posterior vertical step 5-8mm anterior to auxiliary tube on upper first molar, allowing slight retrusive activation, C. Retrusion utility arch with the loop anterior to the anterior vertical step is activated while the molar segment is retruded, and D. Protrusion utility arch with posterior vertical step fitting flush against auxiliary molar tube **(McNamara, 1986).**

### B. Burstone's continuous intrusion arch

The continuous intrusion arch is a 0.016×0.022 or 0.017×0.025-inch beta Titanium archwire that extends from an auxiliary molar tube to the incisors by-passing the canines and premolars to apply an intrusive force on the incisors. This wire contains a step bend just distal to the lateral incisors and V-bend anterior to the molar tube. As the wire is brought down to the central incisors or the lateral incisors, only single forces are directed in an apical direction. To control the anchorage posteriorly, a relatively rigid anchorage unit connects the teeth of the posterior segment usually 0.018×0.025-inch steel archwire or transpalatal arch could be implemented (Figure 13). The cuspid is by-passed by placing a small step in the region of the cuspid or eliminating the cuspid bracket

entirely. Anterior teeth are connected together with an incisor segment wire **(Burstone, 2001, Burstone and Choy, 2015)**.

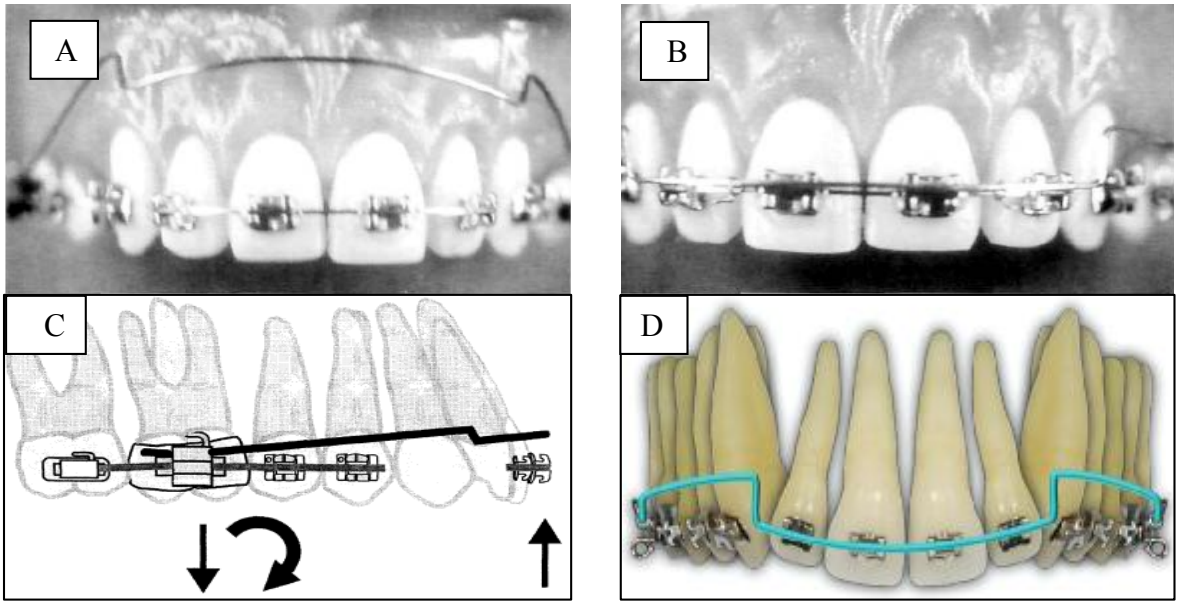


**Figure 13.** Burstone's continuous intrusion arch. A. Frontal view in the passive form, B. Frontal view in the active form, C. and D. Biomechanical effects on the molar and incisors **(Burstone, 2001, Burstone and Choy, 2015).**

The key to successful intrusion is control of the force system. Specifically, force magnitude, constancy, the use of only a single-point application, control of the direction of force, and the selection of a proper point for the force application should be carefully planned and delivered. Force magnitude can be determined using a force gauge. The magnitude of force depends on the number of teeth and their size. For example, during intrusion of upper incisors, about 60 g of force for four incisors are used. The use of low force and a stable anchorage unit will not upset the posterior anchorage and should maintain the original plane of occlusion **(Burstone, 2001; Pokharel and Shrestha, 2023)**.

A particularly important consideration in intrusion is to assure that the intrusion arch does not fit into the brackets of the incisors to apply pure intrusion force, instead a separate segment is placed. Inserting the intrusion arch directly in the bracket slot will cause intrusion, flaring (palatal root torque) and mesial

displacement of the roots of incisors. So the wire should be ligated to the brackets of the lateral incisors or cinched back distal to the molar tube. However, in case of class II division 2 where the maxillary incisors are retroclined, the intrusion arch could be ligated between the central incisors or left without cinch to promote incisor flaring. This is favorable in low angle case to open the bite and help deep bite correction. The moment created on the molars will be clockwise resulting in distal crown tipping and extrusion in addition to lingual crown tipping, so transpalatal arch or heavy gauge archwire inserted in the slots of the second premolar and both molars tubes is mandatory to prevent this side effect **(Burstone, 2001)**.

### C. Connecticut intrusion arch

Connecticut intrusion arch introduced by Ravindra Nanda in 1998 and it is fabricated from NiTi alloys as it is the material of choice for delivering continuous forces under large activation. This can be used in treating cases with deep bite, open bite and occlusal canting. A modified Connecticut intrusion arch is manufactured from beta Titanium archwire **(Nanda *et al.*, 1998; Sharma *et al.*, 2015)**.

This wire incorporates the characteristics of utility arch as well as those of conventional intrusion arch **(Amasyali *et al.*, 2005)**. They are preformed wires with appropriate bends necessary for easy insertion and use. Two wire sizes are available; 0.016×0.022 and 0.017×0.025-inch, maxillary and mandibular versions with anterior dimensions of 34 mm and 28mm respectively (Figure 14). The by-pass located distal to lateral incisors is available in two different lengths to accommodate for extraction, non-extraction and mixed dentition **(Nanda *et al.*, 1998; Pokharel and Shrestha, 2023)**.

The basic mechanism of force delivery is a V-bend calibrated to deliver approximately 40-60g of force. Upon insertion, the V-bend lies just anterior to the molar brackets. When the arch is activated, a simple force system will be

resulted and consist of vertical force in the anterior region and a moment in the posterior region **(Nanda *et al.*, 1998; Sharma *et al.*, 2015)**. This is clear in Figure 14.

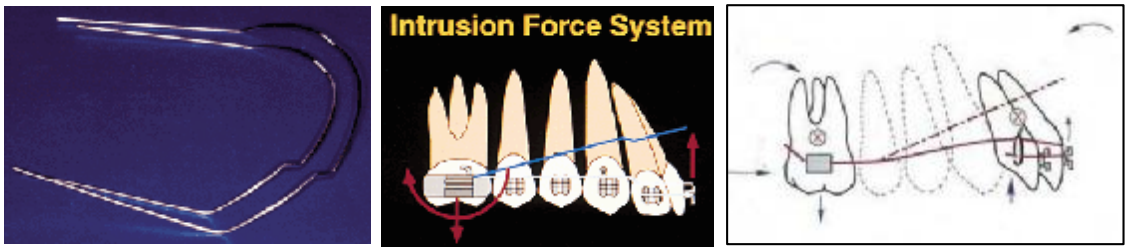


**Figure 14.** The Connecticut intrusion arch in the left. The biomechanical effect of Connecticut intrusion arch on the molar and anterior teeth in the middle and right photos **(Nanda *et al.*, 1998; Proffit *et al.*, 2019)**

If the intrusion arch ligated in the area of lateral incisors, it will exert an intrusive force, but if it ligated between the central incisors, it will exert intrusive force with flaring of the incisor crowns (which is favorable in treating class II division 2 or upright incisors) and this can be prevented by cinching the wire behind the first molar **(Lindauer and Isaacson, 1995; Nanda *et al.*, 1998; Proffit *et al.*, 2019)**.

This wire will remain active at a constant force level for a long period of time, allowing long intervals between appointments and virtually eliminating the need for adjustments. Its simplicity of design and minimal requirement for auxiliary hardware make it an ideal addition to the armamentarium of the busy clinician **(Nanda *et al.*, 1998)**.

### 1.2.4.6 Applying torquing on the anterior teeth

One of the methods for applying torque on the anterior teeth is the placement of torquing archwire. The torquing archwire is a 2×4 appliance incorporating a V-bend just distal to the bracket of lateral incisors **(Isaacson and Rebellato, 1995)**.

The desirable low load deflection rate properties of a torquing arch are gained by the long span resulting from inserting the archwire into the incisor and molar brackets, but not into the canine or premolar brackets. The V-bend does not require a helix when using beta Titanium archwire which is more comfortable for the patient. The anterior segment of the wire lies gingival to the incisors, but the vertical force at the incisor is extrusive with palatal root torque and advancing if the wire has not be cinched posteriorly. In case of cinching, the effect will be incisors palatal torque, with extrusion and distal movement in addition to intrusion and mesial movement of the molars (Figure 15).

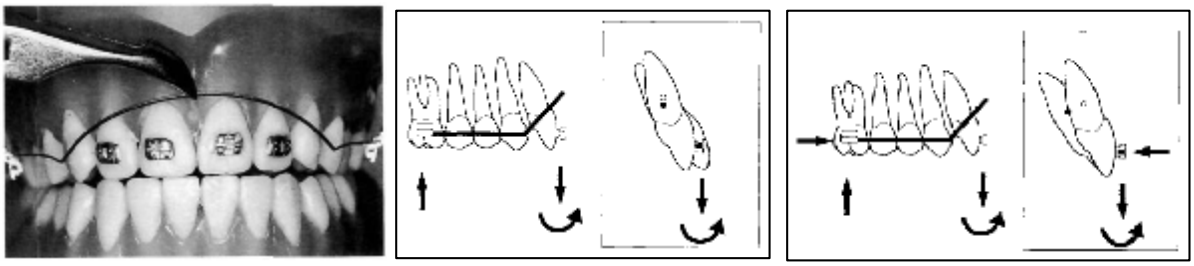

**Figure 15.** Torquing arch in the left photo. Inserting the torque arch in the slot of the incisor brackets will cause palatal root torque, extrusion and advancing of the incisors with intrusion of the molar as shown in the middle photo. Cinching the wire behind the molar tube will cause palatal root torque, extrusion and distal movement of the incisors, with intrusion and mesial movement of the molar as shown in the right photo **(Isaacson and Rebellato, 1995)**

When the torquing arch is left in place for several months, some incisor second-order rotations also occur and the roots will diverge distally. This is a function of the torsion in a three dimensional wire and can be corrected with a normal continuous arch wire as soon as the torquing arch is removed **(Isaacson and Rebellato, 1995)**.

### 1.2.5 Clinical recommendations and precautions

The straight orthodontic wires employed in the 2×4 technique must be thin in diameter at the beginning to appropriately provide light, continuous, and well-controlled force over the incisors. These wires will be subjected to fracture,

slippage or cause trauma to the cheek. This can be solved by **(Dowsing and Sandler, 2004)**:

1. Placement of a long supporting well-shaped stainless-steel tube or plastic sleeve on the archwire, filling the entire space between the first molar and the incisors. This tube strengthens the long unsupported span of the wire from distortions due to occlusal forces.
2. Annealing the extra-wire distal to the molar tubes to allow the wire segment to be turned down (cinched) against the tube, but this procedure prevents the archwire from sliding forward thus avoiding a possible arch length increase and may cause potential undesirable forward movement of the first permanent molar.

### 1.2.6 Evidence supporting the 2×4 appliance

Reviewing the literature reveals the presence of three randomized clinical trials comparing the treatment outcome between 2×4 appliance and other appliances.

**Gu *et al.* (2000)** compared the effect of 2×4 appliance and face mask in treating cases with false class III. They found a similar amount of overjet correction in the 2×4 and reverse headgear groups. Overjet correction by the simple fixed appliance was produced by dental changes whereas in the reverse headgear group, it was produced by both dental and skeletal changes.

**Wiedel and Bondemark (2015)** compared the effectiveness of 2×4 and removable appliances in treating anterior crossbite with functional shift in mixed dentition and found that both appliances are effective with significantly less duration of treatment performed by the 2×4 appliance.

Recently, **da Silva *et al.* (2023)** compare the efficacy and efficiency between clear aligners and 2×4 fixed appliances for correcting maxillary incisor position irregularities in the mixed dentition. They conclude that clear aligners and 2×4 mechanics display similar efficacy and efficiency for maxillary incisor position

corrections in the mixed dentition and the choice of appliance should be guided by clinician and family preference.

Another two non-randomized clinical trials were conducted to compare the efficiency of NiTi Connecticut intrusion arch with the utility arch **(Amasyali *et al.*, 2005)** and with Beta Titanium Connecticut intrusion arch **(Sharma *et al.*, 2015)** and both of these studies proved that all mechanics were effective in intruding the anterior teeth.

### 1.2.7 Modifications of 2×4 appliance

Two modifications for the 2×4 appliance were reported in the literature. One described by **Rebellato (1995)** and called it 2×6 appliance as he included the canines and the other one described by **Tsui *et al.* (2009)** and called it 1×2 appliance as they included both molars and the canine only to move the canine bodily (Figure 16).

**Figure 16.** The modified 1×2 appliance **(Tsui *et al.*, 2009).**

# Chapter Two

# Discussion/ Comments

Malocclusions can be detected at any stage of the dentition and do not self-correct, so they must be treated as soon as possible **(Da Silva-Filho *et al.*, 2006; Sunil *et al.*, 2017)**. Mixed dentition is a period in which occurs rapid growth and development of the craniofacial skeleton. Several types of malocclusions can be successfully managed during this stage because hard tissues are highly responsive to orthodontic forces, and soft tissues exhibit a greater degree of adaptability, thereby increasing the stability of treatment results, it also may ensure the normal development of teeth and jaws **(Andley *et al.*, 2019)**.

A variety of potential benefits from early fixed orthodontic treatment in mixed dentition has been proposed in the dental literature to enhanced oral hygiene, patient's appearance, psychosocial condition, and self-perception/esteem to reduce teasing and bullying **(Rohilla *et al.*, 2017; Solanki *et al.*, 2017; Fleming, 2017; Andley *et al.*, 2019)**.

One of the most important appliances is the 2×4 appliance. This appliance is versatile, easy to manipulate and can manage a variety cases of dental malocclusion in short period of time and with good control on teeth movement. On the other hand, it may not cancel the second phase of orthodontic treatment in the future. Placement of bands can be difficult in not fully erupted permanent molars so buccal tubes can be used instead, and it neither corrects skeletal malocclusions nor suitable for primary dentition.

Good knowledge about the uses and biomechanics used in treating different cases of malocclusion using 2×4 appliance is mandatory for general practitioner and pedodontists in solving simple cases while other cases can be managed by specialist orthodontists.

# Chapter Three
# Conclusions and Suggestions

## 3.1 Conclusions

The 2×4 appliance is suitable, versatile, and very efficient in treating different malocclusion in the mixed dentition patients, because of the light, continuous and well-controlled orthodontic forces applied, particularly when removable appliance usage is a critical problem. Therefore, this fixed orthodontic device can be used in different clinical situations with only negligible alterations in the speech and esthetics with fewer disadvantages regarding traditional removable approaches. Different types of 2×4 appliance are described with their indications, advantages and biomechanics.

## 3.2 Suggestions for Further Studies

1. A national survey among Iraqi orthodontists is required to investigate how wide spread is the use of the 2×4 appliance, why and how they use it and the length of treatment.
2. Randomized clinical trials are needed to verify the clinical effectiveness, outcomes of early treatment, the orthodontists' preference, and psychological impact of this appliance in comparison with the removable orthodontic appliances or clear aligners in treating different types of malocclusion.

# References


**A**

- Agarwal, A. and Mathur, R. (2011) Segmental orthodontics for the correction of crossbites. *International Journal of Clinical Pediatric Dentistry,* 4, 43–47.
- Alami, S., Aghoutan, H., El Quars, F., Diouny, S., and Bourzgui, F. (2015) Early treatment of anterior crossbite relating to functional class III. In Virdi, M. (ed.). *Emerging trends in oral health sciences and dentistry*. 1st ed. InTech. Chapter 16, 341-361.
- Amasyali, M., Sağdiç, D., Ölmez, H., Akin, E., and Karçay, P. (2005) Intrusive effects of the Connecticut intrusion arch and the utility intrusion arch. *Turkish Journal of Medical Sciences,* 35, 407-415.
- Andley, Y., Saraf, B.G., Sheoran, N., and Nisha, N. (2019) Too much too soon, rather than in too little or too late: orthodontic in mixed dentition. *International Journal of Applied Dental Sciences,* 5, 374–381

**B**

- Bench, R.W., Gugino, C.F., and Hilgers J.J. (1978) Bioprogressive therapy Part 7: The utility and sectional arches in Bioprogressive therapy mechanics. *Journal of Clinical Orthodontics,* 12, 192-207.
- Bennett, J.C. and McLaughlin, R.P. (2014) *Fundamentals of orthodontic treatment mechanics*. 1st ed. St. London: LeGrande Publishing.
- Bhalajhi, S.I. (2006) *Orthodontics: The art and science*. 3rd ed. New Delhi: Anja (Med) Publishing House.
- Bishara, S.E. (2001) *Textbook of orthodontics*. 1st ed. Philadelphia: W.B. Saunders Company.
- Brito, G., Simões, D., Flores, P.S., and Machado, A.W. (2020) An effective approach to correcting anterior crossbite in a class III patient. *Journal of Clinical Orthodontics*, 54, 705-711.

- Buitrago, D.F.L., and Saavedra, C.M.C. (2015) Therapeutic management of a pseudo class III malocclusion. Case report. *Revista Mexicana de Ortodoncia*, 3, 248-254.
- Burstone, C.J. (2001) Biomechanics of deep overbite correction. *Seminars in Orthodontics,* 7, 26-33.
- Burstone, C.J. and Choy, K. (2015) *The biomechanical foundation of clinical orthodontics*. 1st ed. Chicago: Quintessence Publishing Co, Inc.

**D**

- Das, L., Sarkar, A., Banerjee, D., Adak, A., Saha, S., and Sarkar, S. (2020) Catch them young: early interception of malocclusion in mixed dentition period using 2×4 appliance. *International Journal of Current Research,* 12, 10247-10250.
- da Silva V.M., Ayub, P.V., Massaro, C., Janson, G., and Garib, D. (2023) Comparison between clear aligners and 2×4 mechanics in the mixed dentition: a randomized clinical trial. *The Angle Orthodontist,* 93, 3–10.
- Da Silva-Filho, O.G., Silva-Lara, T., Bibiano, G.F., and Fernández-Sánchez, J. (2006) 4×2 leveling: importance of its application in mixed and permanent dentition. *Spanish Orthodontics,* 46, 167–178.
- Dowsing, P. and Sandler, J. (2004) How to effectively use a 2×4 appliance. *Journal of Orthodontics,* 31, 248–258.

**F**

- Fleming, P.S. (2017) Timing of orthodontic treatment: early or late? *Australian Dental Journal,* 62, 11–19.
- Fleming, P. and Seehra, J. (2019) *Fixed orthodontic appliances a practical guide*. 1st ed. Switzerland: Springer.
- Foster, T.D. (1990) *A textbook of orthodontics*. 3rd ed. Oxford: Blackwell Scientific Publication.

**G**

- Garrocho-Rangel, A., Hernández-García, G., Yáñez-González, E., Ruiz-Harika, R., Dwijendra, K.S., Arun, P., and Swetha, SS. (2016) Correction of midline diastema and rotated incisors using a versatile fixed partial appliance in mixed dentition: a case report. *Pediatric Dental Care,* 1, 116–118.
- Graber, T.M. and Vanarsdall, R.L. Jr. (2000) *Orthodontics current principles and technique*. 3rd ed. St. Louis: Mosby.
- Gu, Y., Rabie, A.B., and Hagg, U. (2000) Treatment effects of a simple fixed appliance and reverse headgear in correction of anterior crossbites. *American Journal of Orthodontics and Dentofacial Orthopedics*, 117, 691-699.

**H**

- Hussain, U., Ayub, A., and Farhan, M. (2013) Etiology and treatment of midline diastema: a review of the literature. *Pakistan Orthodontic Journal,* 5, 27–33.

**I**

- Isaacson, R.J. and Rebellato, J. (1995) Two-couple orthodontic appliance systems: torquing arches. *Seminars in Orthodontics,* 1, 31-36.

**L**

- Lindauer, S.J. and Isaacson, R.J. (1995) One-couple orthodontic appliance systems. *Seminars in Orthodontics,* 1, 12-24.
- Littlewood, S.J. and Mitchell, L. (2019) *An introduction to orthodontics*. 5th ed. Oxford: Oxford university press.
- Loli, D. (2017) The versatility of the 2×4 appliance. *Webmed Central Orthodontics,* 8, WMC005397.

**M**

- McNamara, J.A. (1986) Utility arches. *Journal of Clinical Orthodontics,* 20, 452-459.

- McKeown, H.F. and Sandler, J. (2001) The two by four appliance: a versatile appliance. *Dental Update,* 28, 496–500.

**N**

- Naidu, S. and Suresh, A. (2018) The applications of 2×4 appliance during mixed dentition. *Acta Scientific Dental Sciences, 2*, 49–51.
- Nanda, R., Marzban, R., and Kuhlberg, A. (1998) The Connecticut intrusion arch. *Journal of Clinical Orthodontics,* 32, 708-715.

**P**

- Phulari, B.S. (2017) *Orthodontics principles and practice*. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers.
- Pokharel, P.R. and Shrestha, S. (2023) A short review of intrusion arches in orthodontics. *International Journal of Oral Health,* 3, 1–3.
- Proffit, W.R., Fields, H.W. Jr., Larson, B.E. and Sarver, D.M. (2019) *Contemporary orthodontics*. 6th ed. Philadelphia: Elsevier.

**R**

- Rebellato, J. (1995) Two-couple orthodontic appliance systems: activations in the transverse dimension. *Seminars in Orthodontics*, 1, 37-43.
- Reyes, A., Serret, L., Peguero, M., and Tanaka, O. (2014) Diagnosis and treatment of pseudo-class III malocclusion. *Case Reports in Dentistry*, 2014, Article ID 652936.
- Rodríguez, S., Rosales-Berber, M., and Pozos-Guillén, A. (2023) 2×4 appliance in the mixed dentition stage: a scoping review of the evidence. *Journal of Clinical Pediatric Dentistry,* 47, 1-8.
- Rohilla, M., Bodh, M., Kumar, A., and Namdev, R. (2017) Early interception using 2×4 appliance: a case series. *International Journal of Advances in Case Reports,* 4, 226–229.

**S**


- Sharma, S., Vora, S., and Pandey, V. (2015) Clinical evaluation of efficacy of CIA and CNA intrusion arches. *Journal of Clinical and Diagnostic Research,* 9, ZC29-ZC33.
- Shrimahalakshmi, Chowdhary, N., Thimmaiah, M., Peddi, R., and Shivanna, V. (2023) Interceptive orthodontic treatment using the versatile 2×4 appliance: A case report. *Indian Journal of Public Health Research and Development,* 14, 309-312.
- Singh, G. (2015) *Textbook of orthodontics*. 3rd ed. New Delhi: Jaypee Brothers medical publishers (P) Ltd.
- Singhal, P., Namdev, R., Jindal, A., Bodh, M., and Dutta, S. (2015) A multifaceted approach through two by four appliances for various malocclusions in mixed dentition. *Clinical Dentistry,* 9, 14–19.
- Sockalingam, S.N.M.P., Khan, K.A.M., and Kuppusamy, E. (2018) Interceptive correction of anterior crossbite using short-span wire-fixed orthodontic appliance: a report of three cases. *Case Reports in Dentistry,* 2018, 1–5.
- Solanki, P.J., Choudhari, S.R., Vaghela, C.M., and Saxena, S.I. (2017) Use of the two by four appliance: a treatment modality for the correction of malaligned maxillary anterior teeth during mixed dentition period. *International Journal of Development Research,* 7, 17729–17732.
- Soni, S., Bafna, Y., Choski, K., Patel, J., and Kotadiya, J. (2019) Early orthodontics interception in mixed dentition using 2×4 appliance: a series of 3 case report. *Journal of Medical Science and Clinical Research*, 7, 44-49.
- Subramanyam, D. (2019) Modified two by four appliance for single tooth anterior crossbite correction. *International Journal of Current Advanced Research,* 8, 17424-17426.

- Sunil, M.M., Zareena, M.A., Ratheesh, M.S., and Anjana, G. (2017) Early orthodontic interception of anterior crossbite in mixed dentition. *Journal of International Oral Health,* 9, 88–90.

**T**

- Takane, V.V., Keluskar, K.M., Shirsat, S., and Shetty, G.P. (2019) Rapid maxillary expansion in a pseudo Class III malocclusion with blocked out maxillary canines. *International Journal of Orthodontics and Rehabilitation*, 10, 180-184.
- Tsui, V.W.K., Alkhal, H.A., Hou, H.M., Wong, R.W.K., and Rabie, A.B.M. (2009) The modified two-by-one fixed orthodontic appliance for bodily movement of canine: a case report. *Cases Journal*, 2, 211.

**W**

- Wiedel, A.P. and Bondemark, L. (2015) Fixed versus removable orthodontic appliances to correct anterior crossbite in the mixed dentition—a randomized controlled trial. *European Journal of Orthodontics,* 37, 123-127.

**Y**

- Yanez, E.E.R. (2008) *1001 Tips' for orthodontics and its secrets*. 1st ed. Miami: AMOLCA.
- Yordanova, G., Mladenov, M., and Gurgurova, G. (2016) Cross-bite treatment and problems during the early stages of developing of the dentition in the frontal area. *International Journal of Science and Research,* 5, 1506–1510.