PASSIVE SELF-LIGATION from A to Z

Edited by **Nasib Balut**, DDS, MS

QUINTESSENCE PUBLISHING

Dedication

I dedicate this book to my family—especially to Susu for your understanding, love, support, and everything you have done for me—and to my daughter, Nur, and my son, Samir, who have always been my focus, my love, and my happiness.

Library of Congress Cataloging-in-Publication Data

Names: Balut, Nasib, editor.
Title: Passive self-ligation from A to Z / edited by Nasib Balut.
Description: Batavia, IL : Quintessence Publishing Co, Inc, [2022] |
Includes bibliographical references. | Summary: "This book is
the how-to guide for passive self-ligation in orthodontics, from
diagnosis to bracket placement to finishing—and everything in between"--
Provided by publisher.
Identifiers: LCCN 2021059954 | ISBN 9781647240998 (epub)
Subjects: MESH: Orthodontic Brackets | Orthodontic Wires | Orthodontic
Appliance Design
Classification: LCC RK521 | NLM WU 426 | DDC 617.6/43--dc23/eng/20220113
LC record available at https://lccn.loc.gov/2021059954

A CIP record for this book is available from the British Library.
ISBN: 9781647240998

QUINTESSENCE PUBLISHING
USA

Quintessence Publishing Co, Inc
411 N Raddant Rd
Batavia, IL 60510
www.quintpub.com

5 4 3 2 1

Editor: Leah Huffman
Design: Sue Zubek
Production: Sue Robinson

Archwire Sequence with the Damon System

Juan Fernando Aristizábal/
Juan Carlos Solorio

7

Before we can plan any archwire sequence, we need to understand the basic concepts of orthodontic biomechanics, including metallurgy, arch form, and springs, to minimize unwanted effects and moments.

Wires and Metallurgy

The forces that move the teeth during active orthodontic treatment essentially come from the archwires we use. The wires store energy that is later released, generating stimuli on the periodontal ligament and producing chemical, biologic, cellular, and molecular changes that allow for dental movement.

The biophysical behavior of orthodontic wires is usually expressed in load-deflection curves (Fig 7-1). The load units are on the y-axis, and the deflection product is on the x-axis. The common reference value is the behavior of stainless steel, an alloy that follows Hooke's law, which means that for every unit of load, there is one proportional deflection unit. The slope of the curve (elastic modulus or Young modulus) accounts for the stiffness characteristics of the given archwire.

The three fundamental properties of elastic devices are stiffness, strength, and working range.[1]

Strength is the ability of a wire to withstand a load that deforms it without exceeding the plastic deformation limit. It is also the maximum load that a wire can deliver up to the limit allowed by the material. Strength depends on stiffness and working range.[1] *Working range* is the range that a given wire will bend before permanent deformation occurs.

Perhaps stiffness is the most important variable to consider in the clinical selection of an archwire. *Stiffness* is a measure of resistance to deformation, or in other words, a measure of the force required to deform the material at a defined distance.[1]

IN THIS CHAPTER:

- Wires and metallurgy
- Alloys
- Arch form
- Stops
- Auxiliary springs (coil springs)
- Phase 1: Light round CuNiTi archwires
- Phase 2: High-technology rectangular CuNiTi archwires
- Phase 3: Major mechanics with heavy rectangular archwires (SS or TMA)
- Phase 4: Finishing and detailing
- Clinical cases

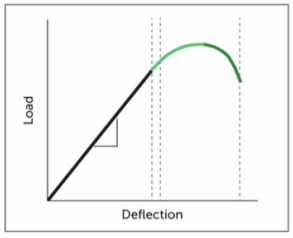

Fig 7-1 Load-deflection curve for stainless steel.

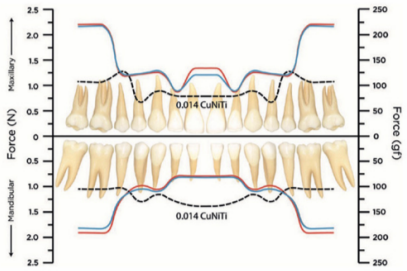

Fig 7-2 Comparison of ideal force *(red line)*, forces of traditional CuNiTi archwires *(dotted line)*, and the SmartArch *(blue)*. (Reprinted with permission from Olsen.[3])

Alloys

The Damon System uses a variety of archwires, from classic stainless steel alloys (nickel chrome)—which are useful in final transverse shaping of the arches, final torque expression, and sliding mechanics—to alloys with high superelasticity and thermoelasticity potentials and intermediate stiffness, such as β-titanium and copper-nickel-titanium (CuNiTi) alloys, to alloys with multiple shape memories (SmartArch, Ormco).

Stainless steel

In orthodontics, alloys that resist the action of external chemical agents are called *stainless steel*. Commercial steel is an alloy of iron or ferrite, which in its natural form is a very soft and unstable material. Metals such as chromium, nickel, and carbon give it hardness.[1]

CuNiTi

CuNiTi alloys represent the ultimate expression of superelasticity based on variable transformation temperature. These alloys can change their crystalline phase at a given temperature, ensuring that hysteresis (a property that allows the strength of an archwire's unloading curve to be lower than its loading curve, making it much nobler in strength levels) allows its most biologic behavior.

Titanium-molybdenum and β-titanium

β-titanium-molybdenum alloy (TMA) was developed in 1980 for orthodontic applications. Titanium is a metal with a hexagonal structure and a higher modulus of elasticity than stainless steel. β-titanium is an alloy that has a centered and more stable cubic shape that contains 11% molybdenum, 6% zirconium, 4% tin, and 79% titanium in cubic β-phase structure.[1]

Clinical applications of β-titanium alloys

β-titanium offers moderate levels of strength, formability, and resilience. It has 42% the stiffness of stainless steel and twice the flexibility.[1] Adapting the classic Burstone geometries, [2] this is a wire that, while having equal dimensions, can offer different sectorized forces throughout its length[3] (Fig 7-2).

The fundamental principles of the Damon System are based on the generation of biologic forces that act in optimal ranges of tissue activation without compromising the adaptive capacity of the cellular components of the periodontal ligament. In order to achieve this, in classic 0.022 × 0.027 slot systems, one should never go beyond an archwire of 0.019 × 0.025, simply because of an engineering premise that dictates that the larger the cross-sectional dimension, the higher the stiffness in the system and the greater chance of damage to the biologic tissue response system.

New alloys, such as the SmartArch, allow for fewer working archwires and act in much more biologic ranges on each tooth with their optimal forces according to the periodontal ligament area unit.

Fig 7-3 *(a to f)* Transverse development sequence.

Arch Form

As discussed in chapter 1 of this book, the dental arch form in the Damon System will not depend on a specific geometric shape. This is precisely one of the Damon System qualities, allowing each patient to develop their own arch form with the help of the archwires in the first two stages: the initial phase with round CuNiTi archwires, and the second phase with high-tech rectangular CuNiTi archwires. As such, there are not coordinating CuNiTi archwire options for maxillary and mandibular arches in the Damon System in commercial terms. There is simply no need with the use of light-force archwires; a single archwire with a single shape can be used during the first two phases of treatment. Remember that one of the goals of Damon System is to achieve a "second" development opportunity, especially transversely. Archwires of light strength and ample play between the bracket slot and archwire will help to "break" the balance of external and internal muscular forces, thereby allowing the tongue to recover its space and the dental arches to develop transversely. Goal achieved.

However, at the end of the second stage of treatment, it is essential to individualize the shape of the maxillary and mandibular arches to enable coordination between both arches. This is discussed later in the chapter under phase 3.

In addition to complementing an adequate smile component in mini-esthetics, the transverse development of the dental arches enables a guaranteed arch length gain in phase 1. The natural expression of 0.013 or 0.014 round CuNiTi archwires and the access to rectangular archwires complement the necessary couples to appropriately straighten roots in the posterior segments, controlling inclination and ensuring adequate tooth positioning (Fig 7-3).

The literature has shown that transverse movements with mild to moderate forces and without tilt can achieve very good positional integrity of roots with intact alveolar bone in the posterior segments.[4] On the other hand, Utreja et al[5] have shown in animal studies how 0.014 CuNiTi archwires can generate histologic changes similar to those produced with rapid expansion systems, further showing that there is integrity of the vestibular bone surfaces. In controlled clinical trials, it has also been demonstrated that adequate assembly of passive self-ligating (PSL) systems with high-tech archwires in CuNiTi and Damon form versions during alignment produces better results of transverse development—at least in the mandibular premolar sector—when compared to the assembly of the same archwires with conventional ligating systems.[6]

The myth regarding potential risk of overexpansion or damage to the cortical labial plates of the posterior segments is not associated with the Damon technique but is clearly the result of poor biomechanical management—ie, ignorance of the objectives and philosophy of each one of the treatment phases when the necessary couples that accompany the transverse development are not controlled. Studies such as that by Morais et al[7] that evaluated the integrity of the buccal alveolar bone before and after non-extraction cases have shown final risk results; however, the irregularity index values in this study, with very wide standard deviations, clearly show that under inclusion criteria,

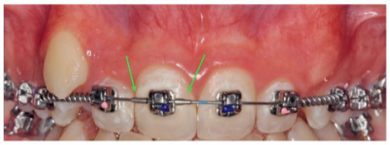

Fig 7-4 Placement of stops in the maxillary arch following the concept of positioning them anterior to the crowding. Remember that these auxiliaries are integrated in each Damon CuNiTi archwire.

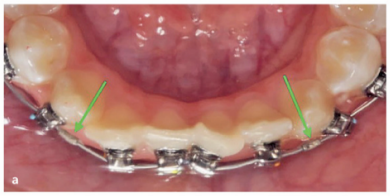

Fig 7-5 *(a)* The *arrows* show the position of the stops that were placed in the mandibular arch. *(b to d)* Alternate placement mesial to the canines.

many of the cases were of clear extraction at diagnosis. This explains why the totality of the teeth would have never been accommodated in the apical base without producing some subsequent damage, in addition to the fact that the tomographies were taken before reaching rectangular archwires.

Stops

All Damon CuNiTi archwires have a pair of closed minitubes (stops) included. These archwires are the ones used during the first two stages of treatment in the Damon System. The function of these stops is to prevent the archwire from sliding to the posterior areas and generating discomfort or irritation for the patient when the ends of the archwire impact the soft tissues of the cheeks.

The stops can be moved to the area or tooth of the clinician's choice, and it is suggested to place them anterior to the crowding. In both arches, this zone is considered to be from mesial of the canine to mesial of the contralateral canine. Dr Damon suggests placing the maxillary stops in the mesial and distal of the maxillary right central incisor for ease and predictability (Fig 7-4). Nevertheless, there are certain important situations to consider, the following among them:

- It is suggested not to place the stops too close to the bracket; at least 1 mm of space should be left between the stop and the mesial or distal face of the bracket. If the tooth is rotated, this distance will allow that rotation to be corrected without precluding it from acting as an anchor. In fact, if the clinician considers that the tooth needs more freedom of space between the bracket and the stops, they can increase the distance between the stops at their discretion. Bear in mind that the position of these stops can be adjusted based on clinical progress or change. You can choose the area to place the stops as long as the principle of placing them anterior to the crowding is respected (see Fig 7-4).
- In the mandible, because the most significant conflict is usually between the central or lateral incisors due to lack of space or severe rotations, you can choose to place the stops between the central incisors, between the lateral incisors, or even mesial to each canine, provided the rotations allow it (Fig 7-5). Remember that the goal of these stops is to prevent the archwire from sliding and impacting the soft tissues of the patient.

Fig 7-6 *(a and b)* Case report of an adult patient with a high degree of crowding and considerable periodontal compromise. It is important to consider not including all the teeth in the first archwire at the beginning of treatment.

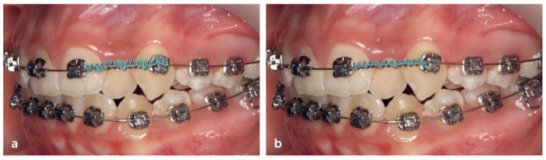

Fig 7-7 Illustration of how to measure and activate a 0.010 medium-strength nitinol spring to achieve the necessary space to include a trapped tooth. *(a)* Nitinol spring from mesial of the maxillary left central incisor to distal of the maxillary left canine. *(b)* Compressed spring exerting gentle force to open the necessary space to include the maxillary left lateral incisor once sufficient space has been achieved.

Auxiliary Springs (Coil Springs)

One of the significant advantages of working with a system that reduces friction is that often it is possible include all the teeth in the first archwire. It is precisely by allowing "play" between the archwire and the slot of the Damon PSL bracket that we obtain some controlled freedom to achieve dental alignment, keeping in mind that the goal of the first stage is to correct 90% of the dental rotations present with round archwires.

However, sometimes dental crowding is so severe that placing an auxiliary, such as a button or eyelet, is practically challenging. This degree of crowding will make it impossible to insert the archwire in all the brackets, no matter how small the wire is. Periodontal compromise may also preclude inclusion of all teeth in the archwire (Fig 7-6). If the space available is too small to include all the teeth, 0.10 medium-strength nickel-titanium open coil springs can be used to open spaces between the most trapped teeth, thereby allowing for subsequent inclusion in the arch.

When using nickel-titanium open coil springs, it is recommended that the spring is activated to the same length as a bracket, at most. For example, if a maxillary left lateral incisor is trapped, the length of the spring should go from distal of the maxillary left central incisor to distal of the bracket of the maxillary left canine (remember that at this moment, the nitinol spring should exceed the length of the space required by the trapped tooth). Once we have selected the adequate length of the 0.010 medium-strength nitinol spring, aided by a plier or a ligature director we can compress that spring in such a way that it is "trapped" between the two previously mentioned brackets (Fig 7-7). The high efficiency of low friction in the Damon PSL System allows the necessary reciprocal force to be minimal, acting directly to achieve the necessary space for the inclusion of the trapped tooth. This is very different from what is observed in conventional ligation systems, where the forces must be greater to account for the energy loss needed to overcome friction.

How is the spring activated and how often?

The recommendation is to activate open coil springs every 4 to 6 weeks. The authors' suggest activation every 4 weeks. If you have decided to see your patient with longer intervals between appointments, it is possible that the first stage of treatment may take a little longer.

A quick and straightforward way to activate a nickel-titanium open coil spring is to use open mini-tubes (also known as *stops*, but it is important not to confuse them with the stops that come in the Damon archwires); this type of auxiliary is sold separately (Fig 7-8). With this method, you compress the spring with a ligature director, place the mini-tube by maintaining that compression, and clamp it to close it over the archwire. These mini-tubes are usually about the same mesiodistal dimension as a Damon bracket. (Closed mini-tubes can also be used but require removal and replacement of the archwire.) Another efficient way to do this is to place a small portion of flowable resin in place of a mini-tube. Another alternative is to change the spring at each appointment, respecting its bracket-length activation.

Fig 7-8 Note the activation mini-tubes for nitinol springs.

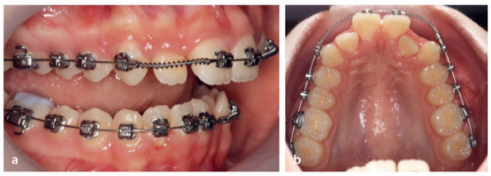

Fig 7-9 *(a and b)* How to achieve the necessary space to include a tooth trapped in the arch. It is recommended that the space obtained with the medium-strength nitinol springs be slightly larger than required for the trapped tooth.

Fig 7-10 *(a)* Bracket placement on the trapped tooth without including it directly in the archwire using a medium-strength nitinol spring to create the space for its later inclusion in the arch. The coil spring and bracket are held with a 0.010 metal ligature. *(b)* Occlusal view.

It is wise to activate the spring further than necessary to allow the trapped tooth to enter freely and not be so tight, meaning that the crowding is completely released before including that tooth in the arch (Fig 7-9). The number of activations necessary to gain the space will depend solely and exclusively on the patient's responsiveness. Ultimately, this auxiliary aims to obtain sufficient space so that the trapped tooth can be included in the archwire without space restrictions.

A clinical recommendation to avoid the closure of the space created by the nickel-titanium spring is to keep the spring and hold the bracket of the trapped tooth with a ligature, slightly flexing the archwire a maximum of 2 to 3 mm toward the bracket of the trapped tooth that we are going to start moving. The trapped tooth will most likely have already moved enough to remove the spring and include it directly in the archwire. This advice considers Newton's third law that dictates that to every action corresponds a reaction, so if you remove the spring with which you have achieved the space and directly include the bracket of the trapped tooth, keep in mind that when the archwire flexes, it will exert an inward force on the teeth neighboring the trapped tooth, thus generating rotations and inclinations toward the area of the created space. Therefore, you would be at risk of losing some of the space gained by the spring as a result of unwanted moments in the teeth neighboring the trapped tooth.

Should trapped teeth be ligated when space is being created to integrate them into the arch?

There are two opinions on this. The first is that button-type auxiliaries, eyelet brackets, or the Damon bracket itself can be used to hold the archwire very lightly with a metal ligature and push it in a very subtle way toward the trapped tooth so that the tooth gradually takes its place in the arch (Fig 7-10). The second, suggested by Dr Chris Chang from Taiwan, is to leave the trapped tooth as a free body (Fig 7-11). For example, in the case of a palatally displaced maxillary lateral incisor that does not have enough space to be included in the archwire, a medium-strength nickel-titanium spring is placed, and the lateral incisor is free to move as a free body. Dr Chang's clinical explanation is that this tooth's physiologic response is to "move away" from the contact it could have with the other roots (of the canine in this case), which will have the effect that the lateral incisor may move a little more toward the palatal; however, this action could prevent the roots from hurting each other. Of course, this brings the question of whether the lateral incisor will have a more compromised position once we have created the space and want to include it in the arch. Nevertheless, with the great advantages of the available torque variables in the Damon System, we know that this effect can be easily solved as the lateral incisor is taking its position inside the arch (Figs 7-12 to 7-14). After evaluation of each case, the clinician will have the opportunity to decide which of these two options is best to correct the dental crowding.

Fig 7-11 *(a to g)* Clinical case illustrating the "free body" concept where a 0.010 medium-strength nitinol spring is used to create the necessary space for the maxillary left lateral incisor. Once space is created, the lateral incisor bracket is placed and ligated to the archwire with a 0.010 metal ligature attaching to the 0.013 or 0.014 CuNiTi spring and archwire. It is suggested that the archwire not be integrated into the lateral incisor bracket at the time of placement; in the same way, it is suggested to keep the nitinol spring to preserve that space and not remove it until the next appointment, integrating the archwire into the slot of the lateral incisor bracket. The treatment sequence illustrated in these images was performed with only one 0.013 CuNiTi archwire.

Fig 7-12 *(a to f)* Clinical case illustrating the use and activation of 0.010 medium-strength open nitinol springs and the first phase of round archwires, respecting the main objective, which is to correct 90% of the rotations. Note how the springs were placed to create spaces for the trapped maxillary lateral incisors.

Fig 7-13 *(a and b)* Comparison in arch form between the first and second stages of treatment with round and rectangular CuNiTi archwires. Note how the crowding has been released and the posterior transverse adaptation has been expressed. *(c)* Final occlusal view after treatment.

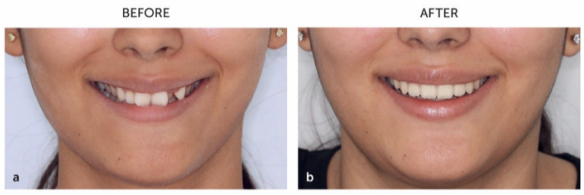

Fig 7-14 *(a and b)* Smile before and after treatment.

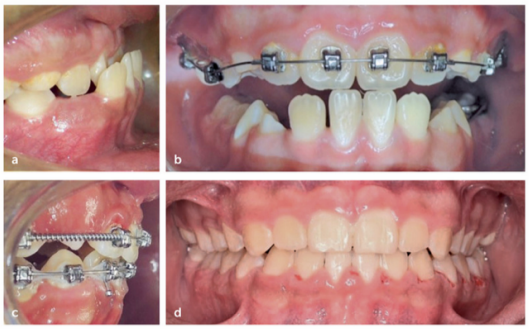

Fig 7-15 *(a to d)* Sequence in pseudo-Class III, using open coil springs and stops placed mesial to the first premolars during most of the arch sequence to generate an advanced arch effect.

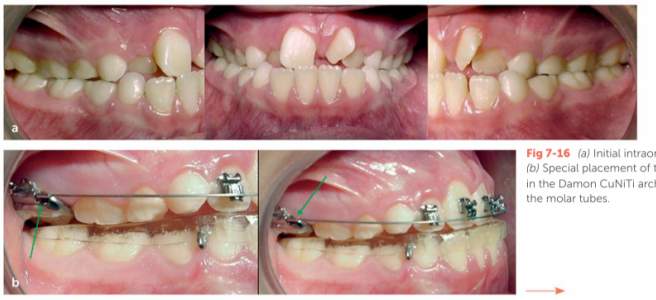

Fig 7-16 *(a)* Initial intraoral photographs. *(b)* Special placement of the stops included in the Damon CuNiTi archwires, mesial to the molar tubes.

Class III cases

Once the four phases of the Damon System treatment are mastered, users can begin to place the stops included in the Damon CuNiTi archwires in different areas according to the malocclusion. For example, in the case of a Class III dentoalveolar malocclusion with an anterior edge-to-edge bite or a slight crossbite, the stops can be placed mesial to the premolars, being in direct contact with the mesial portion of these brackets; this will prevent the archwire from sliding posteriorly and allow an advanced arch effect to solve the anterior discrepancy (Fig 7-15).

An 8-year-old Class III patient presented in the mixed dentition (Fig 7-16a). The stops in the CuNiTi archwire were placed in intimate contact with the mesial part of the tubes in the maxillary first molars (Fig 7-16b), and the 0.014 × 0.025 CuNiTi archwire was left with overextension of 2 mm in the anterior (Fig 7-16c) so that when the archwire was included, it would flex, exerting a force in the anterior direction (Fig 7-16d). To compensate for the force exerted on the maxillary molars and at the same time avoid distalization and increase anchorage, an acrylic splint was used in the mandibular arch with Class III 2-oz ¼ elastics on each side (Fig 7-16e). The sequence of archwires used in this treatment was 0.014 CuNiTi followed by 0.014 × 0.025 in the maxilla only. Treatment time was 12 months (Figs 7-16f to 7-16i).

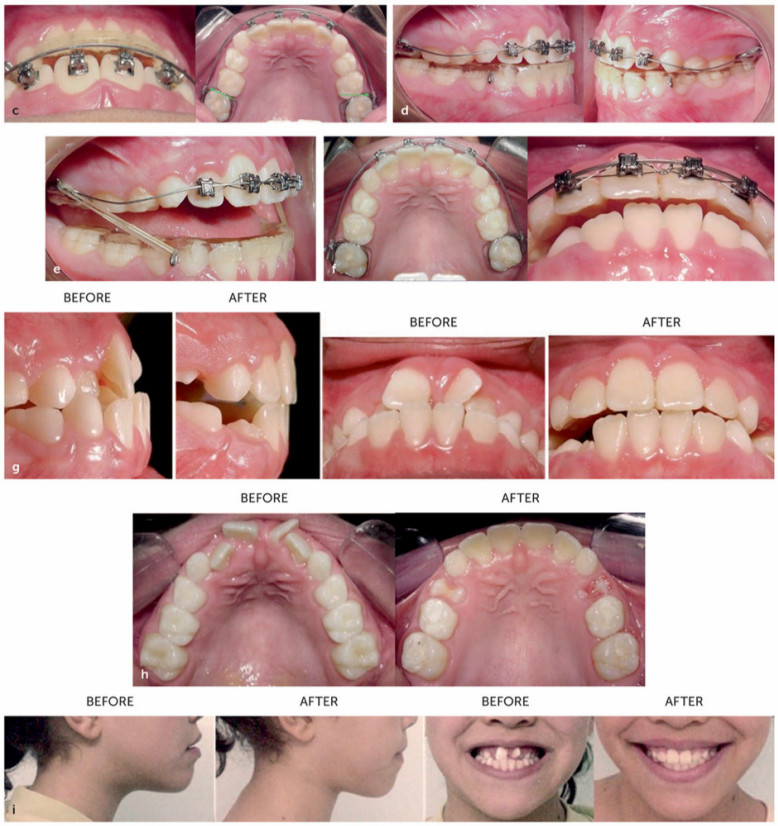

Fig 7-16 *(cont) (c)* "Activated" 0.014 × 0.025 CuNiTi archwire; the stops were firmly clamped mesial to the molar tubes, leaving the archwire 2 mm overextended. *(d)* The 0.014 × 0.025 CuNiTi archwire is inserted into the anterior segment. Note the bending of the archwire, showing what it looks like with a 2-mm overextension activation. *(e)* Anchorage unit with 1/4, 2-oz elastics to prevent the maxillary molars from moving distally and to direct the full force of the activated 0.014 × 0.025 CuNiTi archwire to the anterior maxilla. *(f)* Note the concept of overtreatment to compensate for relapse. *(g)* Horizontal and vertical overbite before and after treatment. *(h)* Maxillary arch before and after treatment. *(i)* Profile and smile views before and after treatment. Treatment duration was 12 months.

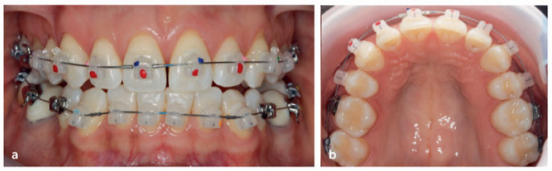

Fig 7-17 *(a and b)* Example of a 0.013 CuNiTi archwire in both arches in an adult patient.

Fig 7-18 *(a and b)* Example of a 0.014 CuNiTi archwire in both arches in a young adult.

Four Treatment Phases

- Phase 1 – Light round archwires
- Phase 2 – High-technology rectangular archwires
- Phase 3 – Major mechanics with heavy rectangular archwires
- Phase 4 – Finishing and detailing

Phase 1: Light Round CuNiTi Archwires

Objectives and philosophy

"Start well to finish better." The beginning of treatment is crucial; the steps taken in this phase will determine whether the patient's case is complicated further or made simpler.

All archwires in this phase are CuNiTi. Sizes include 0.013, 0.014, 0.016, and 0.018. Remember that there are no specific maxillary and mandibular archwires in this commercial presentation; there is only one size of archwire for both arches. Note, however, that one of the characteristics of the new 0.016 SmartArch is that archwires now come in both presentations, for the maxillary and mandibular arches. Consult the Ormco catalog to see all the options available.

CuNiTi archwires are used in this phase because their force remains more constant at a higher deflection of the archwire compared to nickel-titanium. This allows us to work closer to the biozone (see chapter 1) and not overload the system with force.

In cases of severe crowding or in adult patients, the suggestion is to start with a 0.013 CuNiTi archwire (Fig 7-17). Because it is the smallest archwire available for the Damon System, it has greater freedom within the bracket slot, thus theoretically reducing the force that will be released to the periodontal ligament. Remember that we seek to have as much freedom as possible between the bracket slot and the first archwire, hence the suggestion to begin cases with a 0.013 archwire; however, it is also possible to use the 0.014 archwire as the initial archwire (Fig 7-18).

It is also imperative to consider the periodontal phenotype in this phase of treatment. We want to apply the least amount of force possible to achieve the desired movement without damaging the periodontal support structures. Similarly, sometimes the clinical situation could hide a severe periodontal problem, so imaging and other diagnostic tools should always be included in the initial assessment (Figs 7-19 and 7-20).

Clinically, the initial archwire should correct the rotations to a considerable extent before deciding to switch to an archwire of a larger size. In other words, the suggestion when deciding to advance to the next archwire is that the new archwire should not flex more than 2 to 3 mm, either anteroposteriorly or occlusogingivally, to avoid overloading the system (Fig 7-21). For example, if the treatment is started with a 0.013 CuNiTi archwire, it is recommended that the next archwire in the sequence be a 0.016 CuNiTi to continue correcting rotations and leveling the arches. On the other hand, if treatment was begun with a 0.014 CuNiTi archwire, the next archwire in phase 1 would be an 0.018 CuNiTi. The selection of initial archwires will depend on clinical judgment and the necessity to prevent

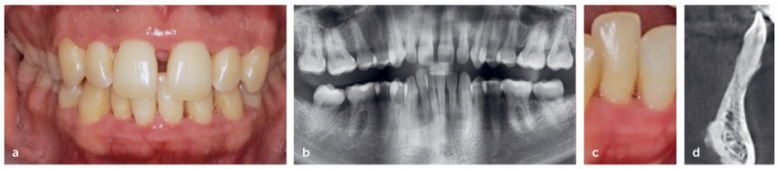

Fig 7-19 *(a to d)* In this patient, the gingival level does not correspond clinically to the actual bone support, hence the importance of periodontal assessment to determine the extent of periodontal disease. Once the decision to initiate orthodontic treatment has been made, the initial archwires should be selected in an attempt to release as little force as possible to avoid damage to the supporting structures.

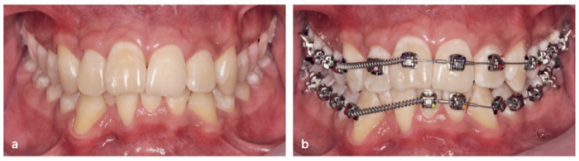

Fig 7-20 *(a and b)* Patient with thin periodontal phenotype and periodontal compromise of the mandibular right central incisor. The recommendation is to release crowding using 0.010 medium-strength nitinol coil springs and initial 0.013 CuNiTi archwires in both arches.

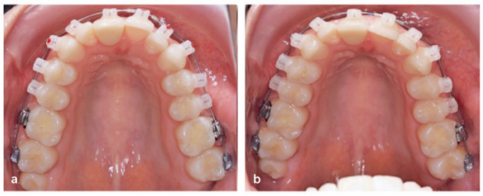

Fig 7-21 *(a)* Initial archwire: 0.013 CuNiTi. *(b)* Second archwire: 0.016 CuNiTi. Note that from the second archwire onward, it is recommended that the bending or activation of the archwire does not exceed 2 mm; this is to avoid overloading the patient's muscular resistance system. Remember that the Damon System philosophy bases its anchorage on the perioral musculature.

unwanted proclinations; the smaller the wire diameter, the lower the force released.

Bear in mind that if 90% of the dental rotations are not corrected with the first two round archwires, repositioning of the brackets should be considered to achieve this particular objective. It is not advisable to continue in the sequence of thicker or "heavier" archwires while trying to still correct these rotations because you will not achieve your goal. It is crucial to correct that 90% of rotations in this first phase (see chapter 1).

How long should the second archwire be in place during the first phase of round archwires?

There is no set time for these archwires to remain in place. Rather, they should stay in place until the goal of 90% correction of rotations has been achieved. Usually this takes from 4 to 6 weeks, but it could take longer depending on the patient. Time is not what matters most; what is important is reaching the goal for each specific treatment phase.

All Damon CuNiTi archwires are marked with a blue stripe on their midline. Take special care to center them properly in the arches to allow for symmetric individual archwire development from the beginning (Fig 7-22).

Some clinicians suggest not including the second molars, especially in the first archwire, as the impact of the food bolus can "take out" the arch from the second molar tube. However, this is a decision that the clinician must make based on the desired management of the vertical control in the posterior segments (Fig 7-23).

Remember that any auxiliaries like bite turbos should be present from the first appointment (see chapter 5).

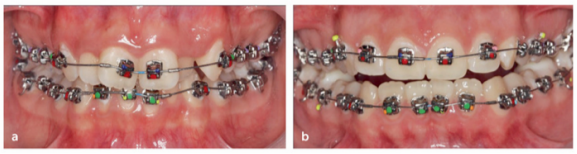

Fig 7-22 *(a and b)* It is vital to center the blue marking on the Damon CuNiTi archwires with the dental midline to achieve dental arch coordination. This example illustrates two different cases in their first treatment arch.

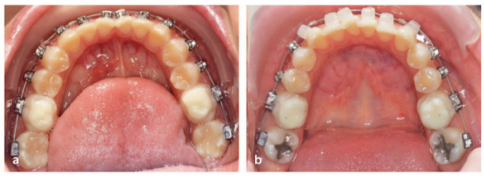

Fig 7-23 *(a and b)* Two clinical examples where the second molars were included in the mandibular arch. It is the clinician's decision whether or not to include them from the beginning of treatment.

Fig 7-24 Clinical case using non-tandem mechanics in a 24-year-old man with a pseudo-Class III, anterior edge-to-edge bite, and crossbite at the maxillary left lateral incisor and canine level, with a mild periodontal problem and lack of plaque control. *(a)* Intraoral photographs at presentation. *(b)* Start of treatment with a 0.014 CuNiTi archwire in the maxilla and 0.013 CuNiTi archwire in the mandible. The brackets were placed with variable torque. High torque was used in the maxilla to attempt maximum possible facial movement of that arch. Standard torque was used in the mandible along with 2-oz Class III elastics and interproximal reduction from mandibular lateral incisor to lateral incisor.

Tandem/non-tandem mechanics

The archwires used in the maxillary and mandibular arches can be the same size (tandem mechanics) or a combination of sizes (non-tandem mechanics). Sometimes we need the force released by the archwire in one of the arches to be slightly higher than in the opposite arch. For example, in a case where we have an edge-to-edge bite and the main objective is to "decompensate" the maxillary arch by "placing" that arch a little more forward, non-tandem mechanics is recommended. This means that treatment in the maxillary arch will begin with a 0.014 CuNiTi archwire, while a 0.013 CuNiTi archwire will be used in the mandibular arch. In this case, we want the movement toward the facial to be less in the mandibular arch than in the maxillary arch to resolve the edge-to-edge bite, hence the smaller archwire in the mandibular arch. When using this combination of archwires, the suggested sequence for the maxillary arch is 0.014 CuNiTi followed by 0.018 CuNiTi, while the sequence in the mandibular arch is 0.013 CuNiTi followed by 0.016 CuNiTi (Fig 7-24).

It is imperative to mention that non-tandem mechanics only apply to the first phase of treatment; both arches should use the same archwire size from the second stage of treatment onward.

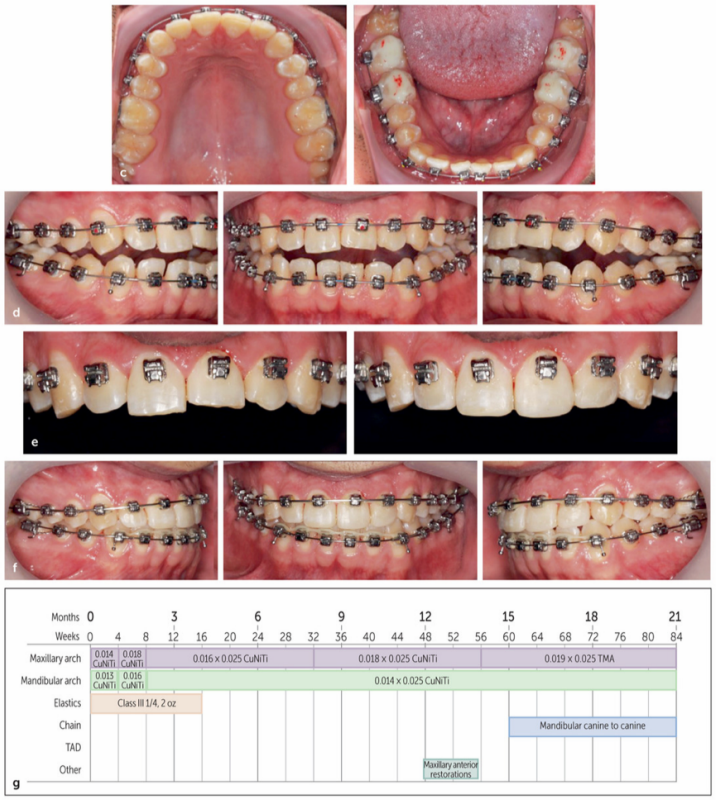

Fig 7-24 *(cont) (c)* Occlusal views of the maxillary and mandibular arches. Note that bite turbos were placed in the mandibular first and second molars to provide a larger occlusal surface for the patient. *(d)* Second phase of treatment with rectangular CuNiTi archwires and mandibular interproximal reduction. *(e)* Correction of micro-esthetics by restoring the shapes and proportions of the maxillary anterior teeth with resins. *(f)* Third phase of treatment with a low-friction 0.019 × 0.025 TMA archwire in the maxillary arch and a 0.014 × 0.025 CuNiTi archwire in the mandibular arch. Interproximal reduction was performed from mandibular lateral incisor to lateral incisor, with a power chain attached only at the canines and passing over the top of the mandibular incisor brackets to achieve a retroclination effect and improve the horizontal overbite. *(g)* Treatment timeline and archwire sequence. Total treatment time was 21 months.

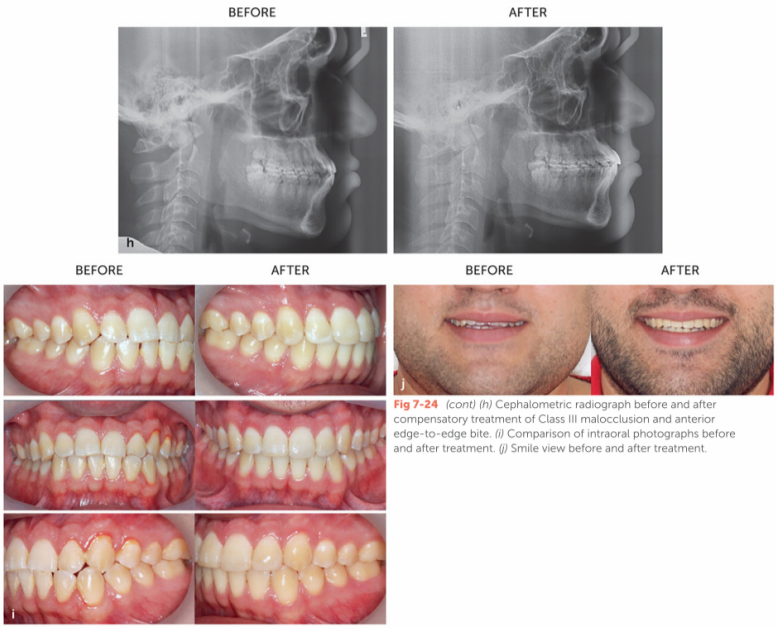

Fig 7-24 *(cont) (h)* Cephalometric radiograph before and after compensatory treatment of Class III malocclusion and anterior edge-to-edge bite. *(i)* Comparison of intraoral photographs before and after treatment. *(j)* Smile view before and after treatment.

Phase 2: High-Technology Rectangular CuNiTi Archwires

Objectives and philosophy

Once 90% of the dental rotations have been corrected, and an acceptable alignment between the teeth or the bracket slots has been achieved, it is time to move on to the second phase of treatment. The second phase is considered the heart and soul of the system because it is precisely at this stage that individual arch development is achieved for the patient.

All archwires in this phase are still CuNiTi. Sizes include 0.014 × 0.025, 0.016 × 0.025, and 0.018 × 0.025. Remember that there are no specific maxillary and mandibular archwires in this commercial presentation; there is only one size of archwire for both arches. Note, however, that one of the characteristics of the new 0.018 × 0.025 SmartArch is that archwires now come in both presentations, for the maxillary and mandibular arches. Consult the Ormco catalog to see all the options available.

Remember that each patient is unique. Therefore, Dr Damon suggests that the archwire of choice for phase 2 should be the 0.014 × 0.025 CuNiTi. This archwire is primarily intended to achieve the patient's individual transverse arch development and continue correcting the missing 10% of rotations to achieve proper alignment. Clinical observations suggest that the 0.014 × 0.025 archwire usually achieves a balance between the external and internal muscular forces acting on the dental arches.

Note that if any of the brackets detach from the teeth when this 0.014 × 0.025 CuNiTi archwire is placed in phase 2, this is an indication that the previous archwire needs more time to work. In this case, place the previous archwire and wait 4 to 6 weeks prior to placing the 0.014 × 0.025 archwire.

Once the 0.014 × 0.025 archwire is in place, a typical suggestion is to let it work for approximately 12 weeks before switching it to an 0.018 × 0.025 CuNiTi archwire. Due to its size and shape, this 0.018 × 0.025 archwire should be used no longer than 4 to 6 weeks, as it could cause an "overexpansion" of the dental arches and lead to a loss of the natural arch form that had been accomplished

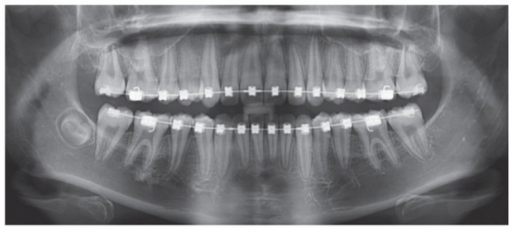

Fig 7-25 Panoramic radiograph taken in the second stage of treatment to assess radicular positions and consider correction before proceeding to the third stage.

with the previous archwires. Ultimately, however, the clinician must decide how long to leave the archwire in place depending on the goals of treatment. For example, if the treatment goal is to achieve greater transverse adaptation in the maxilla because there was a posterior crossbite at the beginning of the case, then it is advisable to let the 0.018 × 0.025 archwire work for a longer time to achieve that goal. In this case, non-tandem mechanics should be applied, and the mandibular arch should continue with the 0.014 × 0.025 archwire until the transversely collapsed maxillary arch has achieved coordination with it.

When do we use the 0.016 × 0.025 CuNiTi archwire?

Dr Damon suggests that this archwire should be used in young patients with little crowding; in these patients, we skip the 0.014 × 0.025 and 0.018 × 0.025 sequence and go straight to using a 0.016 × 0.025 CuNiTi archwire and let it work for 6 to 8 weeks.

Again, remember that the suggestions offered here regarding clinical times should not be taken as hard and fast rules; what is important is that you have a clear idea of what you want to accomplish in this treatment phase. Ultimately, the idea in this second phase is to be able to determine the final shape of the arch and to achieve an alignment of the bracket slots that will allow us to continue with the sequence of archwires suggested for the third phase.

Taking a panoramic radiograph of the progress

Once the 0.018 × 0.025 CuNiTi archwire is in place, it is recommended to take a panoramic radiograph to evaluate the radicular parallelism (Fig 7-25). Alternately, this radiograph could be taken once the 0.014 × 0.025 CuNiTi archwire has been left to work long enough. These are high-precision appliances, so it is essential to correct root positions in these intermediate treatment stages.

If, upon evaluation of the panoramic radiograph, it is determined that root repositioning is warranted, it is recommended to go back to archwires of smaller size and observe how these alignments between the slots are being corrected prior to moving up the archwire sequence until you reach the 0.018 × 0.025 CuNiTi archwire again. This step is crucial, as you must overcome the temptation to change archwires too quickly, which prevents tooth movement from occurring within the optimal force zone (see chapter 1).

Anterior space consolidation

Very often, as the arch develops transversely, spaces may appear between the incisors, either in the maxillary arch, mandibular arch, or both. It is recommended that you evaluate the incisors' alignment at each appointment to prevent this adverse effect. If you determine that they are already aligned but you still need to continue using the CuNiTi rectangular archwires, you should place a figure-8 0.010 ligature from canine to canine under the archwire. Placing this ligature under the archwire allows you to continue to have freedom of space between the slot of the bracket and the archwire (Fig 7-26).

In the Damon System, one of the fundamental principles is to try to reduce friction between the archwire and the bracket slot. This is why elastic ligatures are not used to hold the archwire to the bracket. Similarly, it is recommended that auxiliaries such as elastic chains, metal containment ligatures, or anchorage ligatures (twisted) are placed underneath the archwire (Fig 7-27).

Remember that effects like this do not have to be considered either negative or positive. For example, if you have diastemas between your incisors, perhaps these spaces can be used to correct discrepancies in the dental midlines. On many occasions, this space "surplus" could allow you

Fig 7-26 *(a and b)* Figure-8 0.010 metal ligature running from canine to canine beneath the archwire to prevent diastemas from opening in the second phase of treatment.

Fig 7-27 Twisted metal ligature to form an anchorage unit, placed prior to archwire positioning.

Fig 7-28 *(a and b)* Anchorage unit with a metal ligature underneath the mandibular archwire and a power chain also underneath the archwire between the central incisors to pull the mandibular midline to the right. *(c and d)* Once the space between the mandibular central incisors is closed, the anchorage unit of the twisted metal ligature is extended to the mandibular left lateral incisor, and the power chain is moved between the mandibular left lateral incisor and left canine to mesialize the left posterior segment and improve the occlusal relationship. *(e and f)* Comparison of the occlusal relationships of the left side, before and after closing the diastema between the mandibular central incisors. The teeth of the mandibular left quadrant were pulled forward one by one by applying traction and anchorage with the metal ligature and power chain underneath the archwire until the occlusal relation was corrected.

to even mesialize some of the posterior segment, bringing an improvement to the occlusal relationship (Fig 7-28).

When these spaces appear and we are NOT going to use them to correct the midline or occlusal relationships, one suggestion is to evaluate if we have a good occlusal relationship in the posterior areas. Sometimes these spaces are present and we do not know how to close them without risking the posterior occlusal relationships. The way to correct this space is to form anchor blocks under the archwire in the posterior segments. Once posterior anchor blocks are in place, a 0.010 twisted ligature can be inserted from the first molar tube hook to the mesial side of the canine (and equally on the opposite side), and an open chain can be placed from canine to canine to hold each bracket. In this

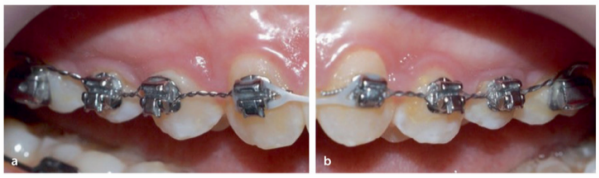

Fig 7-29 *(a and b)* Clinical example of a 0.010 metal ligature twisted to form anchorage units in posterior areas to avoid losing the occlusal relationships when closing small diastemas or spaces between the incisors. This technique can be used in both arches. Remember that the metal ligatures, as well as the elastic chains, are placed *before* placing the archwire.

way, we can close those spaces without losing the posterior relationship (Fig 7-29).

When the dental arches are entirely aligned and leveled with no gaps (especially in nonextraction treatment), it is time to move on to the third phase of treatment.

In some cases with vertical compromise (deep bites), 0.017 × 0.025 or 0.019 × 0.025 archwires with reverse curves can be used in the mandibular arch to complement the biomechanics of relative intrusion, meaning leveling by the extrusion of posterior teeth. Additionally, there are archwires with a reverse curve and 20 degrees of additional torque in the anterior segment. This factory-integrated torque in the archwire is used to compensate for and control the mandibular incisors' natural proclination movement when using an archwire with the reverse curve. However, this type of clinical approach with these mechanics requires a high level of monitoring, especially between appointments, because the loss of control at this stage of treatment with reverse-curve archwires can lead to an open bite that was not part of the original treatment plan.

Phase 3: Major Mechanics with Heavy Rectangular Archwires (SS or TMA)

Objectives and philosophy: What about the arch form?

The first thing to do during this phase is to individualize and coordinate the maxillary and mandibular arches. By now the individual arch development of the patient will have been achieved with the archwires used during the first two treatment phases. To customize the stainless steel (SS) or TMA archwires, we can use two clinical alternatives:

1. Take a record with a red wax sheet, which should be heated and brought to the patient's arch to capture imprints of the incisal and occlusal surfaces as well as the bracket profiles. The bracket profile must be recorded into the wax sheet because this is precisely the trace that we must follow when shaping the SS or TMA archwire that we will use in the third phase of treatment. One suggestion is to take the wax record of the mandibular arch, remove the SS archwire from its individual packaging, and shape the arch following the profile of the brackets with Hollow Chop forceps. Once the individual shape of the mandibular arch is obtained, the maxillary archwire can be shaped to match but made to be 2 mm larger in the faciopalatal direction. These 2 mm facilitate transverse and anteroposterior coordination between the arches.
2. Another option and perhaps a more effective but more time-consuming one is to take a set of working models, which will serve as a reference to follow the individual dental arch forms developed by the patient during the first two phases of treatment. Note in Fig 7-30 how to adjust the SS archwire to the individual arch form of the patient.

The following archwires are usually suggested for this third phase:

- SS: 0.019 × 0.025 and 0.016 × 0.025
- Low-friction TMA: 0.019 × 0.025 and 0.017 × 0.025

It is during this phase that the sagittal, transverse, and vertical corrections should be carried out as required by the case. These archwires are ideal for working heavy Class II or Class III elastics to obtain anterior and posterior torque control. The alloys used to manufacture the archwires plus the size of the archwires used in this phase are precisely what allows us to achieve the main objective: torque expression.

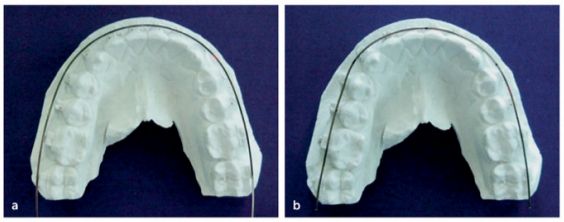

Fig 7-30 *(a)* The arch form of a 0.019 × 0.025 SS archwire straight out of its packaging. Observe how the archwire is overextended, mainly at the premolar and molar levels. *(b)* Observe how the archwire has been shaped at the premolar and molar levels. It is imperative to do this with all patients in both arches to avoid overexpanding beyond the patient's individual arch form. Remember that the patient's muscular system will develop the individual arch form, not us.

Fig 7-31 Example of a 0.019 × 0.025 SS archwire with presoldered hooks. These archwires are also available in 0.016 × 0.025 size.

0.019 × 0.025 SS archwires

The 0.019 × 0.025 SS archwire is a very useful archwire in the Damon System, as it is usually the largest archwire in a regular and average treatment sequence (Fig 7-31). Its primary characteristic is stiffness due to its composition. This is clinically very important because the Damon System uses a 0.022 × 0.027 slot, meaning the 0.019 × 0.025 SS archwire will have enough stiffness to support Class II or Class III mechanics, which are extraction space–closing mechanics. In this situation, the archwire acts as a rigid beam, allowing vertical control in clinical cases. Less stiff wires like 0.016 × 0.025 SS, on the other hand, carry a high risk of deepening bites in the anterior segment, losing the individual arch form, or losing torque control when used with Class II or Class III mechanics. The hooks on these archwires should be positioned between the distal portion of the lateral incisor bracket and the mesial portion of the canine bracket in both arches, and they must be on both sides.

It is crucial during this phase to remain in the biozone (see chapter 1) and stay within the physiologically accepted range of forces of the patient's musculoskeletal system to avoid injury or damage to the tooth-supporting tissues. The 0.019 × 0.025 archwire allows 12 degrees of play in both directions; however, this should not be a situation that prevents you from having control, nor should it be an obstacle to complete and detail your cases with a high degree of efficiency.

Perhaps one of the most common situations regarding anterior torque control is the omission of a vertical hook (either soldered or crimped) between the lateral incisor and the canine on each side of the arch (whether maxillary or mandibular). Initially, this hook serves as support to hold the Class II or Class III elastics, to support the space closure coils in extraction cases, or simply to hold the tiebacks (elastic chains) that go from the hook of the molar tube to the anterior hook of the archwire. However, when it comes to torque, we must remember that there must be a horizontal force to express the torque couple between the torque of the bracket and the dimension of the archwire. In other words, three elements are directly involved in how torque is achieved with PSL:

- Archwire dimension
- Bracket torque value
- Horizontal force

Moreover, it is precisely this third element that is often unintentionally omitted during treatment. Therefore, using a horizontal force from the molar tube hook to the anterior hook of the archwire will enable us to obtain better control of the anterior torque. This horizontal force that goes from the molar tube hook to the SS archwire hook can be considered with the assistance of a power chain, medium-strength nitinol coil springs, Class I elastics, or an activated metal ligature (Fig 7-32).

Likewise, to obtain adequate torque values in the posterior segment, it is essential to consider that we are using a 0.019 × 0.025 SS archwire, which is indicated for space closure mechanics in extraction cases (see chapter 11).

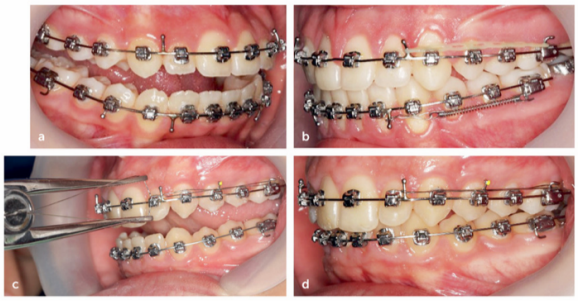

Fig 7-32 *(a)* Maxillary and mandibular 0.019 × 0.025 SS archwires in place. *(b)* A power chain is placed from the maxillary molar hook to the hook on the maxillary archwire. In the mandibular arch, a medium-strength nitinol closing spring is activated and fastened with a metal ligature to the archwire hook and the mandibular molar hook. The goal of both auxiliaries is to release a horizontal force to perform a controlled torque movement in the anterior segment. *(c)* Here a 0.010 metal ligature is being activated with a Coon plier. The idea is to leave tension (horizontal force) between the maxillary molar hook and the archwire hook to express the anterior torque values in a controlled manner. Note how an auxiliary vertical hook was placed on the first premolar to avoid the ligature's impact on the gingival tissue. *(d)* Activated ligature.

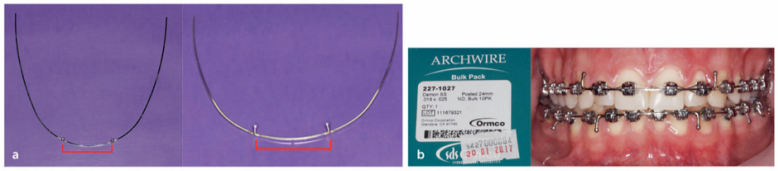

Fig 7-33 *(a and b)* Note the position of the presoldered hooks on the SS archwires.

Fig 7-34 Example of SS archwires without hooks.

SS archwires are manufactured with or without presoldered hooks:

- Archwires with presoldered hooks are available in many variations, starting at 24 mm between hooks and increasing by 2-mm increments all the way to 40 mm (Fig 7-33).
- 0.019 × 0.025 SS archwires without hooks are indicated in cases where no auxiliary force components such as elastics (Class I, Class II, Class III, or midline) or nitinol coil springs are required (Fig 7-34).

Fig 7-35 Commercial presentation of 0.016 × 0.025 SS archwires with presoldered hooks.

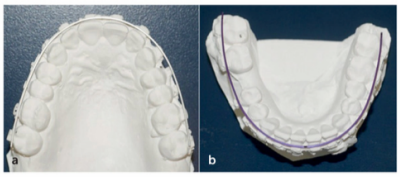

Fig 7-36 *(a and b)* Low-friction TMA archwires to be adapted to the individual arch form.

Fig 7-37 Clinical example of 0.019 × 0.025 TMA archwire in the maxillary arch and 0.017 × 0.025 TMA archwire in the mandibular arch.

0.016 × 0.025 SS archwires

The 0.016 × 0.025 SS archwire is an archwire that we can use in cases where there is no longer mechanical need for correction of dental positions or interarch relationships. An example is a Class I clinical case with moderate crowding where the maxillary arch requires individual torque expression in certain teeth or areas after the second phase of treatment while the mandibular arch is practically resolved without need for heavy Class II or Class III elastics. Here a 0.016 × 0.025 SS archwire will help us keep the individual arch form developed by the patient while we continue to work actively on the maxillary arch. In other words, the 0.016 × 0.025 SS archwire is an archwire that allows us to put a particular arch "on pause" without risking what has been achieved in the first two treatment phases.

Like 0.019 × 0.025 SS archwires, 0.016 × 0.025 archwires are available with and without presoldered hooks:

- Archwires with presoldered hooks are available in many variations, starting at 24 mm between hooks and increasing by 2-mm increments all the way to 40 mm (Fig 7-35).
- 0.016 × 0.025 archwires without hooks are primarily indicated in the mandibular arch, where their main objective is to maintain the shape of the arch developed in the two previous phases. Remember that this archwire has more play between the bracket slot and the wire, so you must consider if this situation is beneficial for your treatment; otherwise, if you wish to have more control, it is suggested that you select a larger archwire such as a 0.019 × 0.025 SS archwire.

It important to note that clinically the 0.016 × 0.025 archwire is suggested when we do not need to rely on hooks for any mechanical action during this phase of treatment. As such, **we suggest considering only the hookless varieties of this archwire.**

Low-friction TMA archwires

Low-friction TMA archwires are mainly used in esthetic brackets because their rigidity is lower than that of SS archwires, thereby protecting the structure of the esthetic bracket. However, we could put stability at risk by decreasing their stiffness, especially in the vertical direction if we use mechanics with heavy Class II or Class III elastics.

This is a condition that the clinician should evaluate when deciding whether to use a metal bracket or an esthetic bracket. Perhaps a possible solution when implementing Class II or Class III mechanics would be to gradually increase the strength of the elastics and evaluate the individual patient's response.

These archwires are also recommended in Class I cases, when only small details of positioning or torque expression are needed after the second phase. Likewise, these archwires would be recommended in cases of compromised periodontal support because the force released is almost 50% that of an SS archwire. Remember that TMA contains titanium stabilized in the beta phase, presenting 40% more elasticity than stainless steels and presenting low-friction conditions in the Damon Low Friction versions, with adequate plastic ranges and excellent conditions for welding or placing auxiliaries (Fig 7-36).

Fig 7-38 Commercial presentation of a 0.017 × 0.025 nitinol archwire with 20 degrees of reverse curve in the lateral incisor to lateral incisor zone.

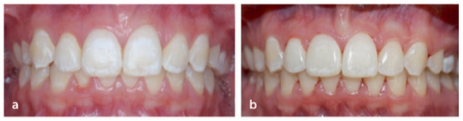

Fig 7-39 *(a and b)* Clinical case treated in the maxillary arch with a 0.017 × 0.025 nitinol archwire with 20-degree anterior pretorque.

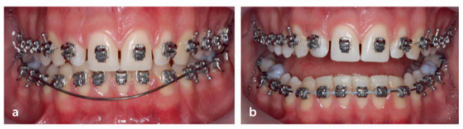

Fig 7-40 *(a and b)* Clinical example of a 0.016 × 0.022 nitinol reverse-curve archwire used in the mandibular arch; a chain is placed above the brackets and holds the archwire to create a compression effect to reduce the proclination effect of the mandibular anterior segment.

These low-friction archwires are available in two sizes: 0.019 × 0.025 and 0.017 × 0.025. The 0.019 × 0.025 TMA archwire is used when we want torque control with a lower force than that of the SS archwire. The 0.017 × 0.025 TMA archwire is recommended when we wish to maintain the integrity of the arch form, especially in the mandibular arch, and when clinically it is not necessary to use more force in the arch (Fig 7-37).

Auxiliary archwires in the third phase of treatment

- Nitinol reverse-curve archwires: available in two sizes, 0.016 × 0.022 and 0.017 × 0.025, with or without torque in the anterior zone
- Nitinol straight archwires with torque: used in the incisor area from lateral incisor to lateral incisor; 0.017 × 0.025 with 20 degrees of torque

If the case requires it and we need the torque to be expressed more efficiently, pretorqued 0.017 × 0.025 nitinol archwires with a 20-degree twist bend should be used in the incisor area (Fig 7-38). The clinician should be careful to observe in detail whether the torque being expressed is positive or negative when using this archwire. In other words, this archwire has a front and a backside, and you should pay full attention to assess the type of torque that the archwire will release. It is suggested to use a Tweed arch plier to assess the torque direction, and in case it is opposite to the one you require, simply turn the archwire 180 degrees and, presto, you will have torque with a different value (Fig 7-39).

Reverse-curve archwires made of nitinol are mainly used as an auxiliary to control vertical leveling in cases of deep overbite. There are archwires with a reverse curve for both the maxillary and mandibular arches, and they are used before placing the SS archwires so that they do not enter so forcefully into the bracket slots, thus avoiding overloading the system.

We can also use 0.016 × 0.025 or 0.017 × 0.025 pretorqued nitinol reverse-curve archwires in the incisor area. We use these archwires, for example, when the curve of Spee is very pronounced in the mandibular arch. When leveling the arch with these archwires, we want to avoid the facial movement of the incisors as much as possible, hence the pretorque built into the archwires. When we use these archwires, it is recommended to place a chain *over* the brackets once the archwire has been included in the slots. It is suggested that the chain goes from first molar to first molar. The chain over the brackets stops any play between the slot and the archwire, while the elastic force compresses the arch to prevent the incisors from moving facially. The power chain can also be used with the same mechanics when reverse-curve archwires without torque are used (Fig 7-40).

Use of tiebacks

Tiebacks are elastic auxiliaries that exert a horizontal force and are attached to the first molar hook and the hook welded or clamped to the arch between the lateral incisor and canine. These elastics are normally used to avoid the opening of spaces in the posterior segments or to avoid the opening of extraction spaces that have already been closed. Tiebacks are necessary to achieve torque expression, especially in the anterior segment. Thus, the clinician must consider using them as an additional tool and not only to prevent space opening.

Tiebacks come in short and long presentations, and their shape is very similar to a power chain with two links widely separated from each other. It is recommended to change them clinically every 3 to 4 weeks because the oral cavity's temperature and humidity degrade the strength of the elastic.

Similarly, we can use a twisted 0.010 metal ligature, firmly tightened with a Steiner or Coon plier, to avoid changing the elastic every 3 to 4 weeks. Alternatively, power chains or Class I elastics can be used.

Phase 4: Finishing and Detailing

Objectives and philosophy

Generally, the archwires used in this phase are the same used in the third phase. For example, if you used an SS archwire in the third phase, you could use this same archwire to make small bends for detailing, such as step-up, step-down, in-set, off-set, or individual torque. However, if you observe that the bending is heavily pronounced and is vital to correct the final position of an individual tooth or a block of teeth, it is recommended that you consider using low-friction TMA archwires (0.019 × 0.025 or 0.017 × 0.025) to reduce the force and avoid injuring the tooth-supporting tissues. This clinical decision must be made on a case-by-case basis.

Note that this fourth phase is omitted in many clinical cases because all the treatment objectives have already been covered in the third phase.

The final torque expression in this phase will be guaranteed by what has been explained in chapter 4 on torque variables. Let's remember that the Damon System uses overcompensations in the torque values to overcome the natural torque play between a 0.019 × 0.025 finishing arch in a 0.022 × 0.027 slot, which is approximately 12 degrees to the occlusal and 12 degrees to the gingival.

There are multiple reports in the literature referring to torque expression inefficiency when using PSL and the low-torque expression efficiency of CuNiTi archwires.[8–10]

Most of these have been performed in vitro, where the bioengineering conditions must privilege the torsional result of the stiffer alloys. This situation presents itself very differently in the clinical setting, where we usually find incisor groups in excellent artistic torque positions at the end of phase 4 because of the adequate biologic response due to the force levels. We should remember that a couple is sufficient to generate the full torque expression and that there is no need for a fourth wall confining the archwire to the bottom of a bracket slot, nor is a metal or elastic ligature necessary to bring the archwire to the bottom of the bracket slot and achieve torque expression. The literature clearly shows that this is a myth,[11] highlighting that the amount of torque expressed by an active self-ligating system when closing the slide does not produce additional effects on the final torque expression when compared to the same system with the slide open.

Clinical Cases

Case 1

This 13-year-old adolescent girl presented with moderate crowding and Class I malocclusion (Fig 7-41). She had inadequate incisor exposure, crowding, transversely narrow arches, and a nonconsonant smile arc.

Treatment goals: The objectives were to correct transverse alterations, correct crowding and the ectopic eruption of the maxillary canines, level the curve of Spee, and correct the midline discrepancy.

Treatment plan: A nonextraction approach was planned for transverse development and smile arc improvement with simultaneous mechanics with early elastics. Damon Q appliances were used: low torque for the maxillary incisors, high torque for the maxillary canines, low torque for the mandibular incisors, and posterior disarticulation with bite turbos.

Phase 1 began with 0.014 CuNiTi light archwires (Fig 7-42). In phase 2, high-tech rectangular 0.014 × 0.025 CuNiTi archwires were placed to initiate torque control, consolidate transverse development, and eliminate remaining rotations (Fig 7-43). A panoramic radiograph was taken during this phase to observe the root positioning and adjust any bracket positions accordingly (Fig 7-44), then the archwires were switched to rectangular 0.018 × 0.025 CuNiTi (Fig 7-45).

In phase 3, the archwire sequence advanced to 0.019 × 0.025 TMA in the maxillary arch and 0.017 × 0.025 TMA in the mandibular arch (Fig 7-46). Finally, in phase

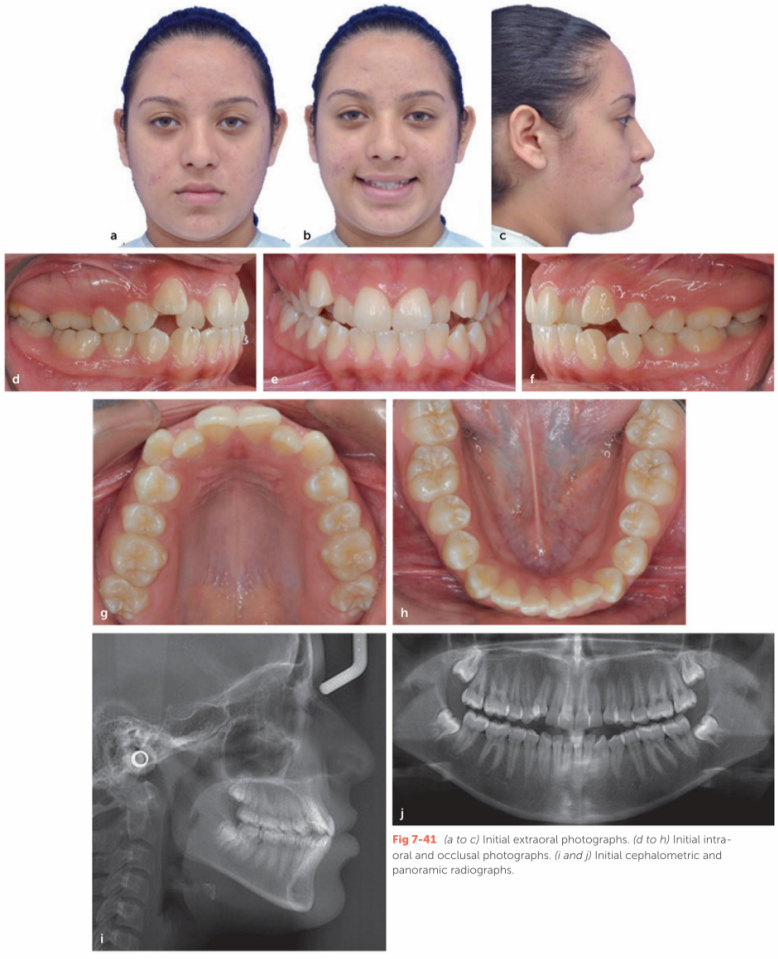

Fig 7-41 *(a to c)* Initial extraoral photographs. *(d to h)* Initial intraoral and occlusal photographs. *(i and j)* Initial cephalometric and panoramic radiographs.

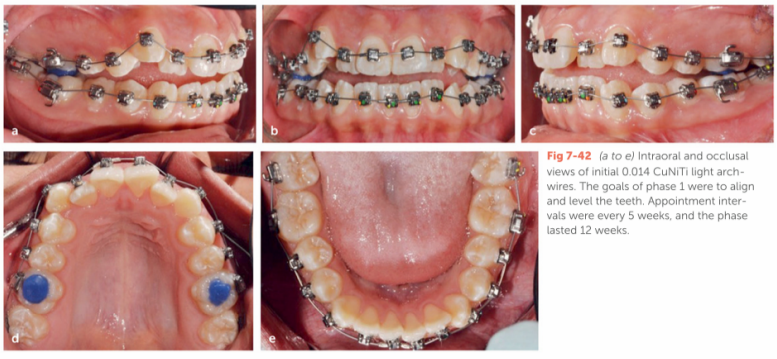

Fig 7-42 *(a to e)* Intraoral and occlusal views of initial 0.014 CuNiTi light archwires. The goals of phase 1 were to align and level the teeth. Appointment intervals were every 5 weeks, and the phase lasted 12 weeks.

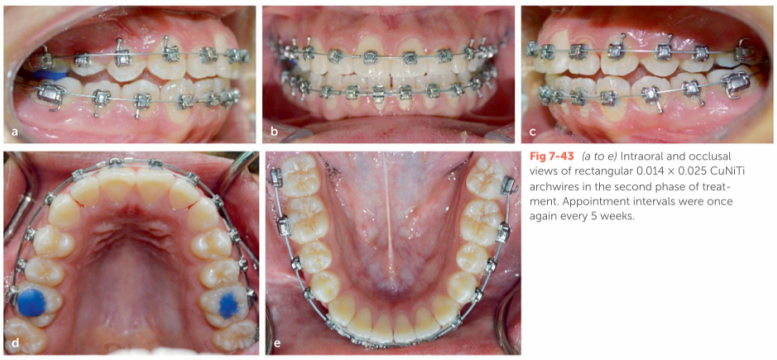

Fig 7-43 *(a to e)* Intraoral and occlusal views of rectangular 0.014 × 0.025 CuNiTi archwires in the second phase of treatment. Appointment intervals were once again every 5 weeks.

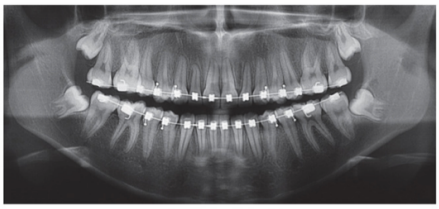

Fig 7-44 Panoramic radiograph taken after complete expression of the 0.014 × 0.025 CuNiTi archwires to generate the necessary bracket repositioning.

4 final detailing was accomplished with 0.019 × 0.025 SS archwires (Fig 7-47).

Figure 7-48 shows the treatment timeline, and Fig 7-49 shows the final results of treatment.

Courtesy of CES University: Drs María Cristina Patiño, Angela Sierra, Giovanni Oberti, and Diego Rey M.

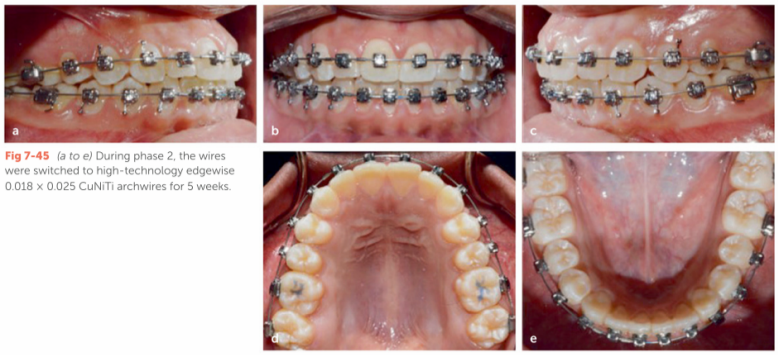

Fig 7-45 *(a to e)* During phase 2, the wires were switched to high-technology edgewise 0.018 × 0.025 CuNiTi archwires for 5 weeks.

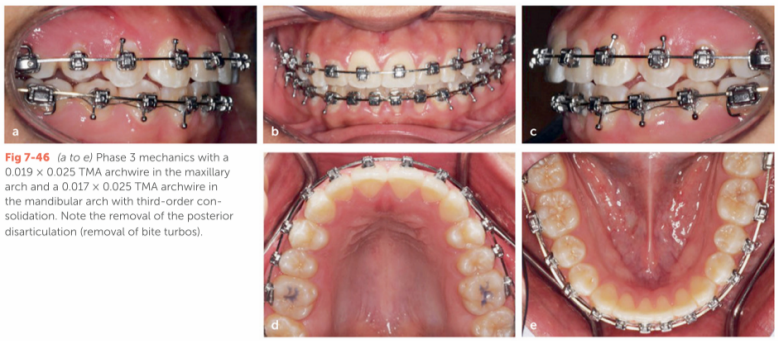

Fig 7-46 *(a to e)* Phase 3 mechanics with a 0.019 × 0.025 TMA archwire in the maxillary arch and a 0.017 × 0.025 TMA archwire in the mandibular arch with third-order consolidation. Note the removal of the posterior disarticulation (removal of bite turbos).

Fig 7-47 *(a to e)* Phase 4 finishing with 0.019 × 0.025 SS archwires for final third-order consolidation, space consolidation, and functional vertical interdigitation.

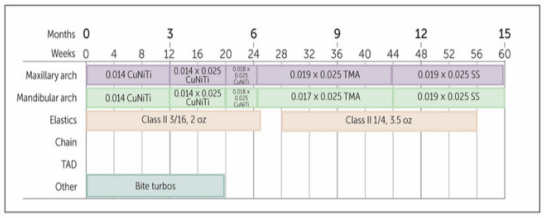

Fig 7-48 Treatment timeline and archwire sequence. Total treatment time was 15 months.

Fig 7-49 *(a to c)* Final extraoral photographs. *(d to h)* Final intraoral photographs.

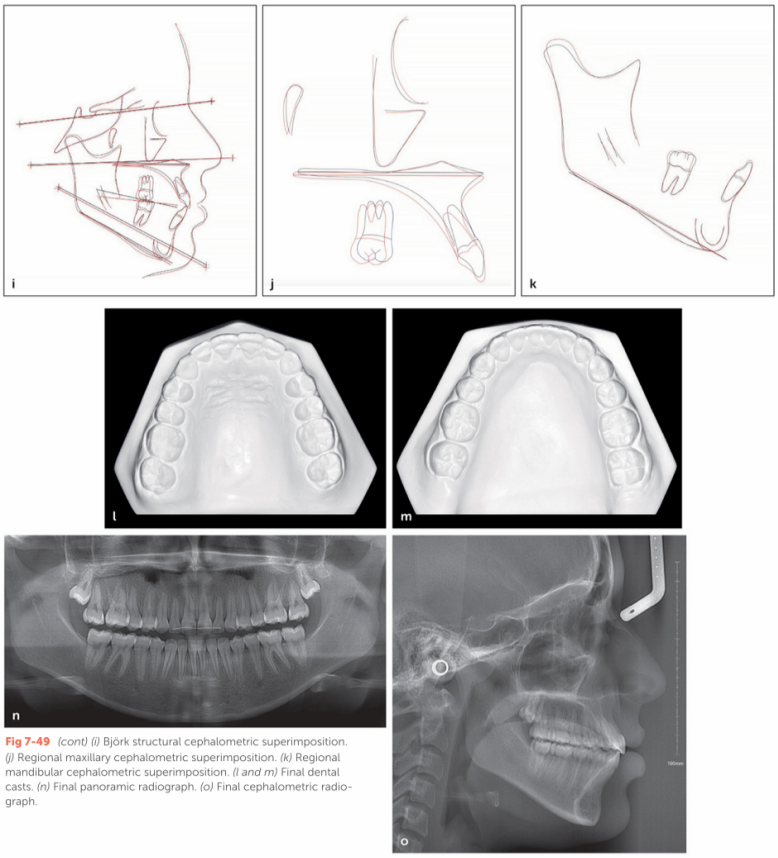

Fig 7-49 *(cont) (i)* Björk structural cephalometric superimposition. *(j)* Regional maxillary cephalometric superimposition. *(k)* Regional mandibular cephalometric superimposition. *(l and m)* Final dental casts. *(n)* Final panoramic radiograph. *(o)* Final cephalometric radiograph.

Fig 7-50 *(a to c)* Initial extraoral photographs. *(d to i)* Initial intraoral and occlusal photographs. *(j and k)* Initial panoramic and cephalometric radiographs.

Case 2

This 12-year-old adolescent girl presented with severe maxillary crowding of approximately 12 mm, an edge-to-edge anterior bite, an existing space maintainer in the mandibular arch (lingual arch), a straight profile, and a skeletal Class I malocclusion (Figs 7-50).

Treatment goals:

- Free maxillary crowding and try to avoid maxillary extractions to prevent affecting the esthetics of the middle third of the face.
- Achieve functional occlusion.
- Maintain or improve facial harmony.

Fig 7-51 *(a to c)* Intraoral view at the start of treatment with a 0.013 CuNiTi archwire placed in the maxillary arch with activated nitinol coil springs. *(d and e)* Occlusal view and horizontal overbite at the beginning of treatment.

Fig 7-52 *(a to c)* Appliance placement in the mandibular arch with a 0.013 CuNiTi archwire and short 2-oz Class III elastics.

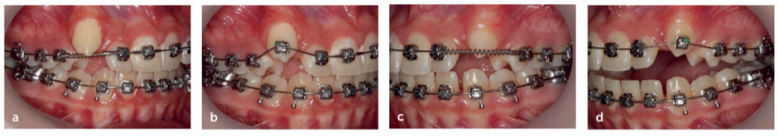

Fig 7-53 *(a to d)* Once sufficient space was created to include the canines in the maxillary arch, brackets were placed on them, and the 0.013 CuNiTi archwire was maintained. A 0.014 × 0.025 CuNiTi archwire can be observed in the mandibular arch, where the following sequence was used: 0.013 CuNiTi for 1 month, 0.016 CuNiTi for 5 months, and then 0.014 × 0.025 CuNiTi.

Treatment plan:

Phase 1: Damon Q Standard Torque Brackets were placed in both arches with light round archwires to correct 90% of the crowding and dental rotations. The maxillary arch had a 0.013 CuNiTi archwire with medium-strength nitinol coil springs, which were activated every 4 weeks (Fig 7-51). One month later, the mandibular appliance was placed using short 2-oz Class III elastics to avoid crossing the anterior bite (Fig 7-52). Once sufficient space was gained in the maxillary arch for the canines to move into the arch, the corresponding brackets were placed, and we continued with the 0.013 CuNiTi archwire (Fig 7-53). The archwire sequence then advanced to 0.016 CuNiTi in the maxillary arch and 0.014 × 0.025 CuNiTi in the mandibular arch. Cross-elastics were used in the maxillary first molars during the first stage to help a little with transverse development of that arch. Note how at the end of phase 1, the objective of solving 90% of crowding and/or rotations in the maxillary arch was accomplished (Fig 7-54).

Fig 7-54 Phase 1 concluded with a 0.016 CuNiTi archwire in the maxillary arch and a 0.014 × 0.025 CuNiTi archwire in the mandibular arch. *(a to c)* Intraoral views. *(d)* Maxillary occlusal view showing the correction of 90% of rotations and crowding.

Fig 7-55 *(a to c)* Phase 2: 0.014 × 0.025 CuNiTi archwires in both arches.

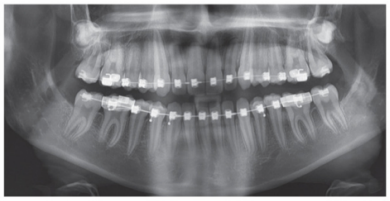

Fig 7-56 Panoramic radiograph of progress.

Fig 7-57 The archwires were switched to 0.018 × 0.025 CuNiTi in both arches after root parallelism was confirmed.

Phase 2: First, rectangular 0.014 × 0.025 CuNiTi archwires were placed in both arches (Fig 7-55), followed by 0.018 × 0.025 CuNiTi in both arches. The goal of this phase was to finish correcting the last 10% of dental rotations and initiate torque control. During this phase, a panoramic radiograph was taken to assess radicular parallelism and consider any necessary repositioning before proceeding to the third phase (Fig 7-56). Once root parallelism was

Fig 7-58 *(a to c)* For this particular case, it was decided to use a 0.019 × 0.025 TMA archwire in the maxillary arch and a 0.017 × 0.025 TMA archwire in the mandibular arch, because it was unnecessary to use auxiliary elements such as heavy elastics, coil springs, etc.

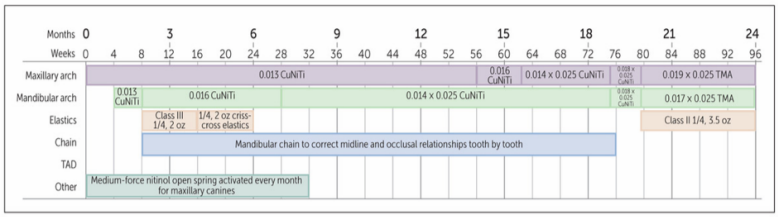

Fig 7-59 Treatment timeline and archwire sequence. Total treatment time was 24 months.

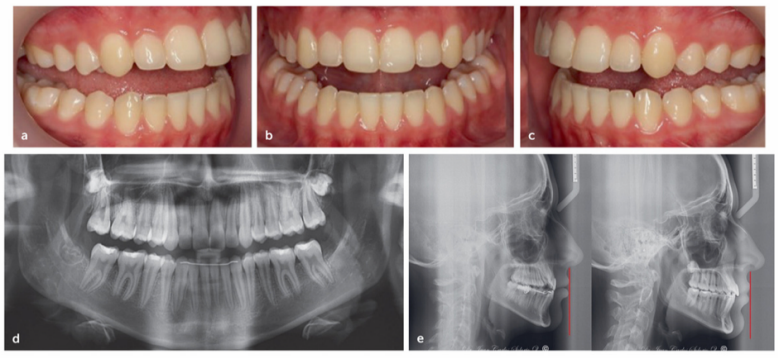

Fig 7-60 *(a to c)* Final alignment and leveling of the occlusal planes. *(d)* Final panoramic radiograph. *(e)* Comparison of cephalometric radiographs before and after treatment.

confirmed, the CuNiTi archwires were switched to 0.018 × 0.025 in both arches (Fig 7-57).

Phase 3: Low-friction TMA archwires were used in the final phase of treatment (Fig 7-58). Figure 7-59 shows the treatment timeline, and Figs 7-60 to 7-67 show the final results of treatment.

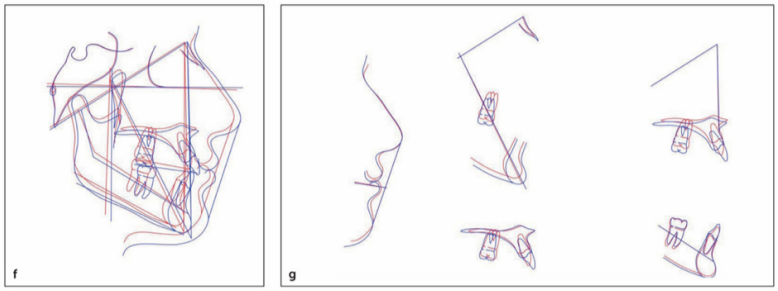

Fig 7-60 *(cont) (f)* General cephalometric superimposition. *(g)* Cephalometric superimposition by area: profile, maxillary, mandibular.

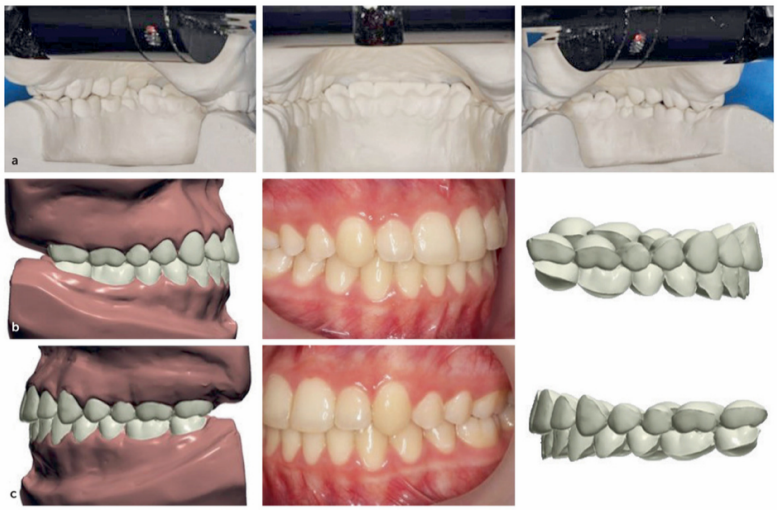

Fig 7-61 *(a)* Internal view of occlusion as seen on casts in the semiadjustable articulator mount. *(b)* Final digital occlusion assessment for right side. *(c)* Final digital occlusion assessment for left side.

Fig 7-62 *(a)* Functional guide, left side. *(b)* Functional guide, right side.

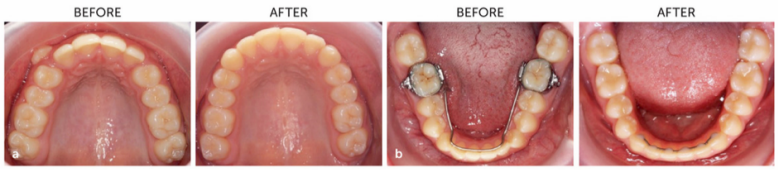

Fig 7-63 *(a and b)* Comparison of occlusal views before and after treatment.

Fig 7-64 *(a and b)* Comparison of intraoral views before and after treatment.

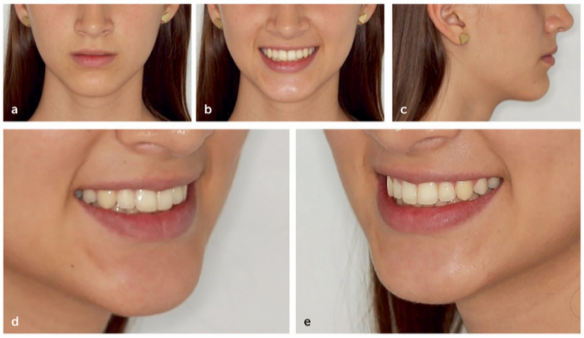

Fig 7-65 *(a to c)* Extraoral photographs at the end of treatment. *(d and e)* Three-quarter smile view at the end of treatment.

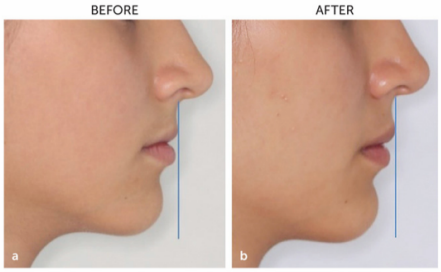

Fig 7-66 Profile and facial harmony before *(a)* and after *(b)* treatment.

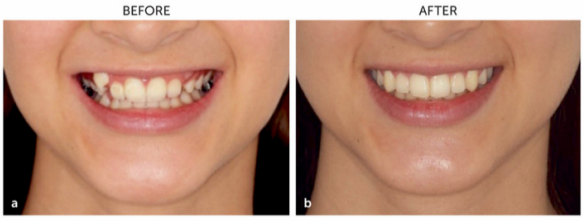

Fig 7-67 Treatment smile comparison before *(a)* and after *(b)* treatment.

Conclusion

An in-depth understanding of biomechanics and the basic concepts of metallurgy are the primary tools to find the right path in orthodontic treatments. PSL offers excellent possibilities in force quality to take advantage of healthy biologic responses with simple protocols.

While the protocols presented in this chapter have proven successful in many clinical cases, arch sequencing is not as simple as following a cooking recipe. Each patient is unique and will require specific modifications and adaptations based on treatment diagnosis and goals, and the clinician must determine these based on clinical judgment. However, the four phases of treatment should be respected to achieve success with the PSL system. A clear understanding of the philosophy and objectives of each phase (see chapter 1) will allow us to achieve the best results.

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