An Organic Polymer Orthodontic Appliance

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To meet the increasing demand for esthetic orthodontic appliances, manufacturers have produced many types of plastic and ceramic brackets.[1] However, except for Optiflex,* which is no longer available, no non-metallic archwires have been introduced until now.[2,3]

We have developed a new, esthetic orthodontic appliance (QCM**) in which the brackets, wires, and attachments are all made of polycarbonate, an organic polymer.

Appliance Design

Plastic wires with homogeneous cross-section do not exert as much force as metallic wires of identical size. These dynamics can be explained by the principle that "bending stiffness is directly proportional to the geometrical moment of inertia, which is a function of the shape of the cross-section of the object, regardless of the nature of its material or the magnitude of force applied on it".[4] Accordingly, we made the cross-section of the plastic wire a "T" shape to yield the geometrical moment of inertia that would generate sufficient force for tooth movement (Fig. 1A).

To hold the wire and efficiently transmit the force to the tooth, the bracket was given a "C" cross-section (Fig. 1B). The plastic archwire is normally inserted into the brackets by sliding it from the canines to the posterior teeth, then snapping it into the incisor brackets without ligation (Fig. 1C). It is removed by cutting it between

*Ormco/"A" Company, 1717 W. Collins Ave., Orange, CA 92867.

**Chikami Miltec, Inc., 1-6-3 Otesuji, Kochi 780-0842, Japan.

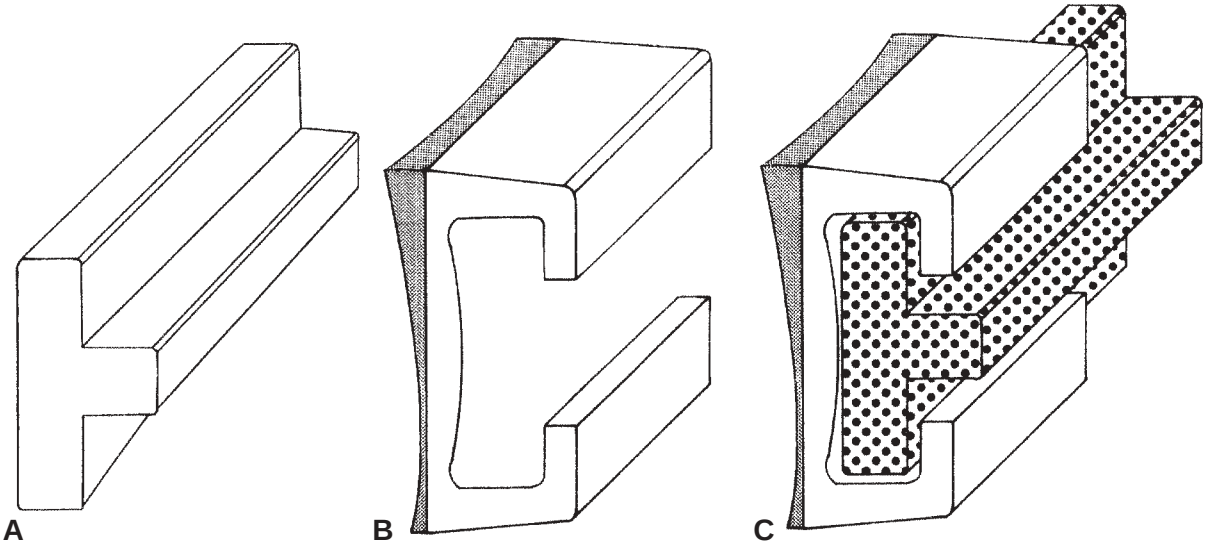

Fig. 1 A. Polymer wire with "T" cross-section. B. Polymer bracket with "C" cross-section. C. Archwire engaged in bracket.

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brackets with a pin-and-ligature cutter, then sliding it out with a plier.

The molar brackets also serve as buccal tubes, unlike those in conventional systems.

Bending Test

A bending test was carried out to compare the new wire with existing metallic wires. The wires were deflected 2mm, at a speed of 90 microns/minute, in a load-unload cycle. The force-deflection curve of the plastic wire rose uniformly up to 1mm, at which point the curve gradually leveled off (Fig. 2). On unloading, the deflection curve diminished rapidly until it reached .4mm of permanent deformation. Although this permanent deformation was greater than that of the metallic wires, the polymer wire exerted adequate force on the tooth.

Case 1

A 22-year-old female presented with a crowded Class I malocclusion (Fig. 3). In the maxillary arch, she displayed severely rotated left incisors, lingually locked lateral incisors, and a porcelain crown on the right central incisor. The mandibular anterior teeth were crowded and irregular.

After the extraction of four first premolars, treatment was begun with canine retraction on sectional archwires to relieve the maxillary crowding and allow easier leveling and alignment, especially of the rotated teeth (Fig. 4A). Seven months later, brackets were bonded to the maxillary and mandibular incisors, and continuous wires were placed in both arches (Fig. 4B). The maxillary incisor rotations were finally corrected by bonding palatal buttons to the lingual surfaces of the teeth and attaching elastics. Because this appliance uses sliding mechanics,

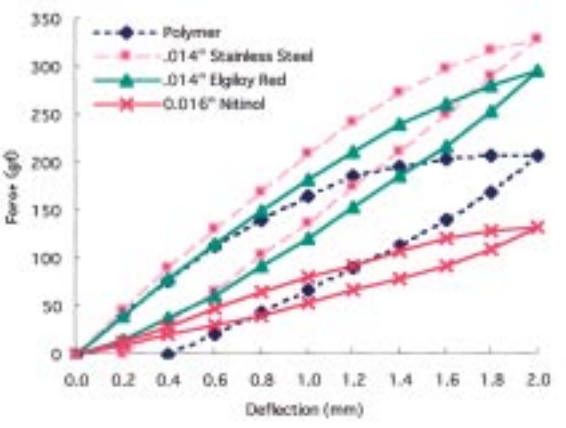

Fig. 2 Bending test of polymer wire compared to stainless steel, Elgiloy Red,* and Nitinol.†**

space closure was completed with elastics (Fig. 4C).

Fixed appliances were removed after two and a half years of active treatment (Fig. 5).

Case 2

A 19-year-old female presented with symptoms of TMD (Fig. 6). She had an anterior open bite and Class I crowding.

The QCM appliance was first placed in the maxillary arch for leveling. A month and a half later, the mandibular first premolars were extracted, and mandibular sectional archwires were inserted (Fig. 7A). The mandibular arch was leveled in another six months, after which the maxillary first premolars were extracted (Fig. 7B). Space closure was completed using intramaxillary and Class II elastics (Fig. 7C).

The case was finished after three years of active treatment (Fig. 8).

***RMO, Inc., P.O. Box 17085, Denver, CO 80217.

†3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016.

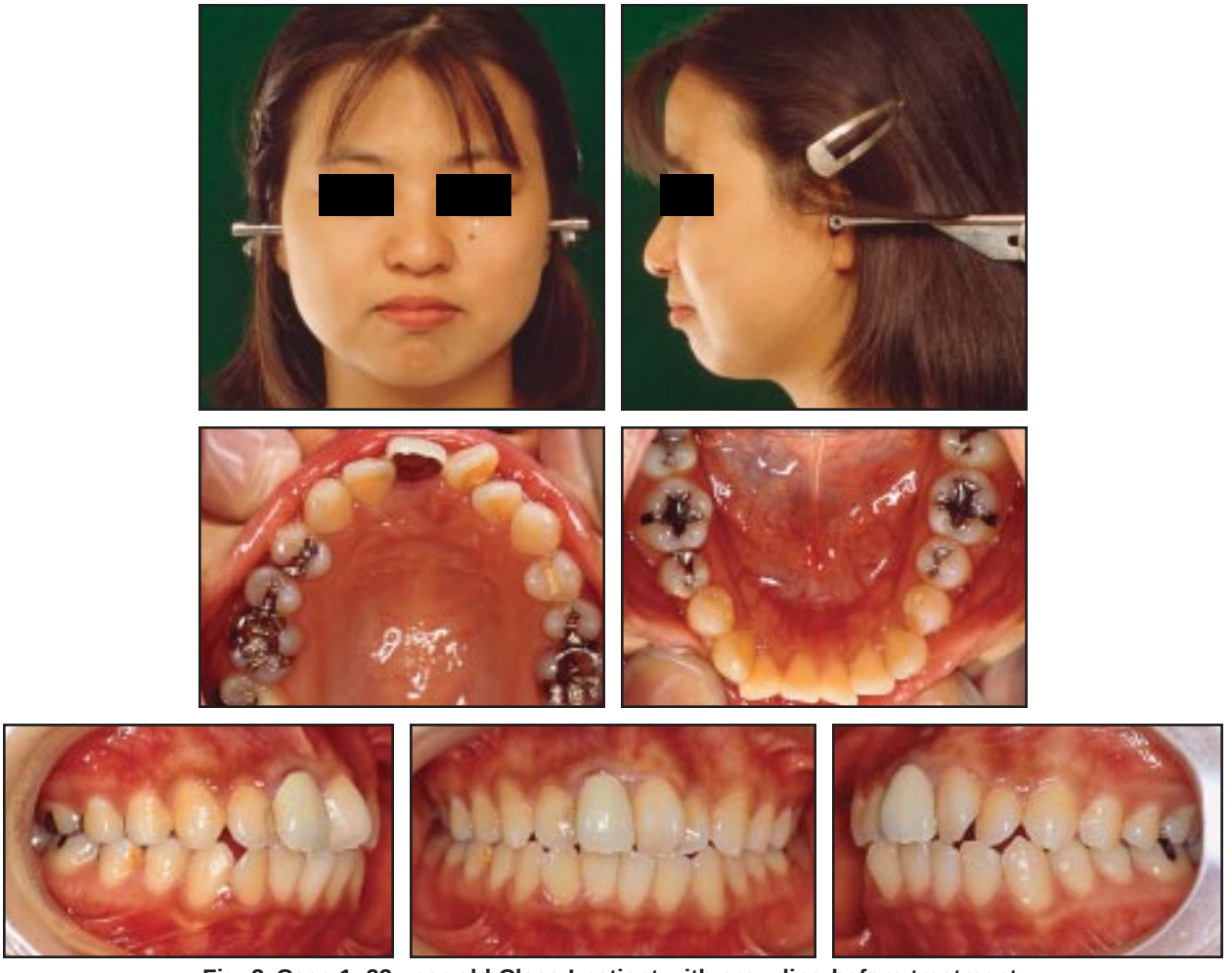

Fig. 3 Case 1. 22-year-old Class I patient with crowding before treatment.

Fig. 4 Case 1. A. Sectional maxillary archwires for canine retraction (continued on next page).

Fig. 4 (cont.) Case 1. B. Continuous wires in both arches after seven months of treatment. C. Space closure with elastics.

Fig. 5 Case 1. Patient after 30 months of active treatment.

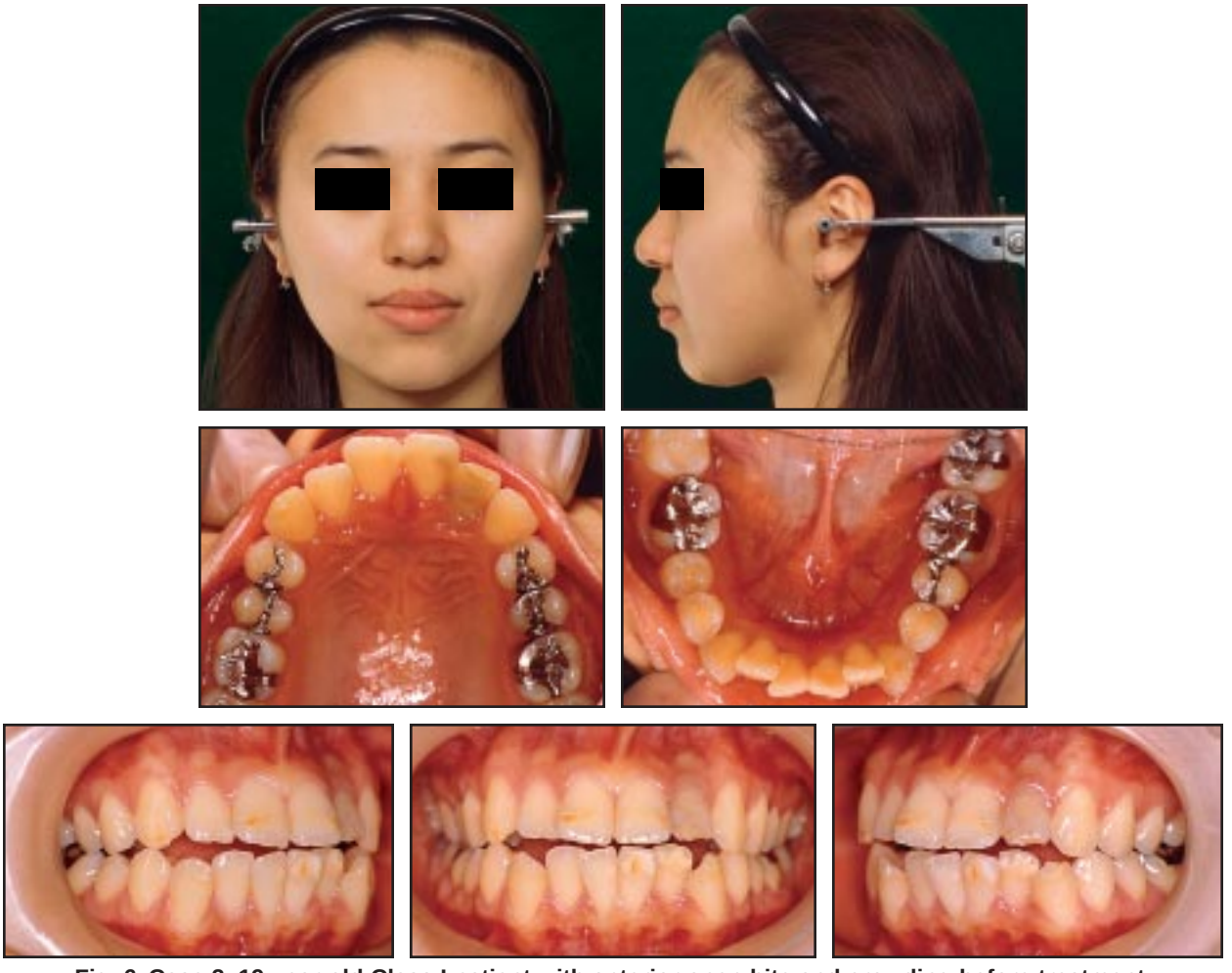

Fig. 6 Case 2. 19-year-old Class I patient with anterior open bite and crowding before treatment.

Fig. 7 Case 2. A. Continuous maxillary archwire and sectional mandibular archwires for canine retraction (continued on next page).

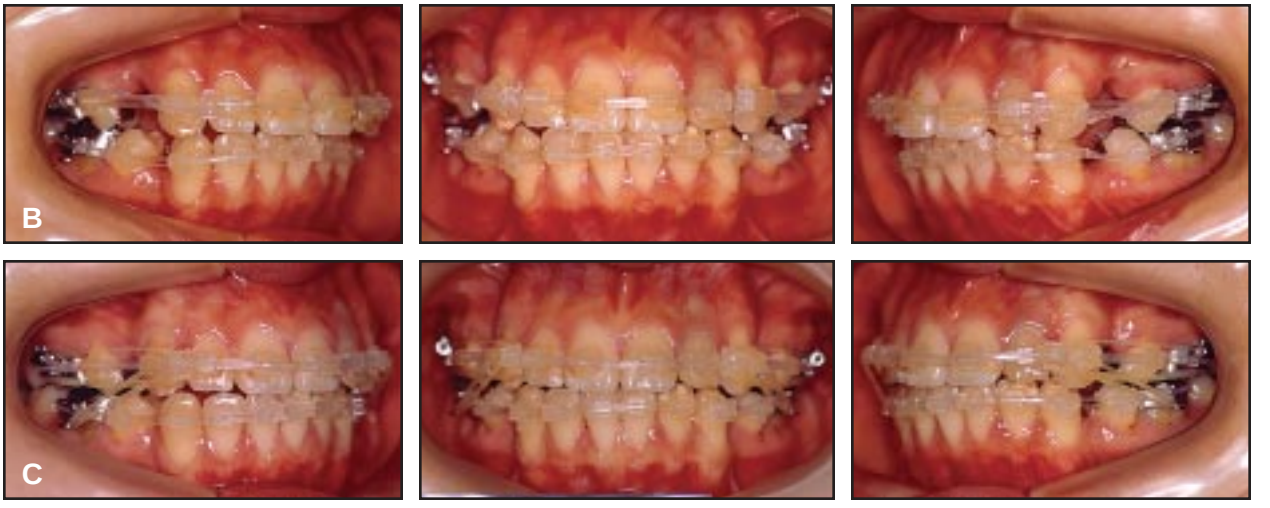

Fig. 7 (cont.) Case 2. B. Continuous wires in both arches after seven and a half months of leveling. C. Space closure with intramaxillary and Class II elastics.

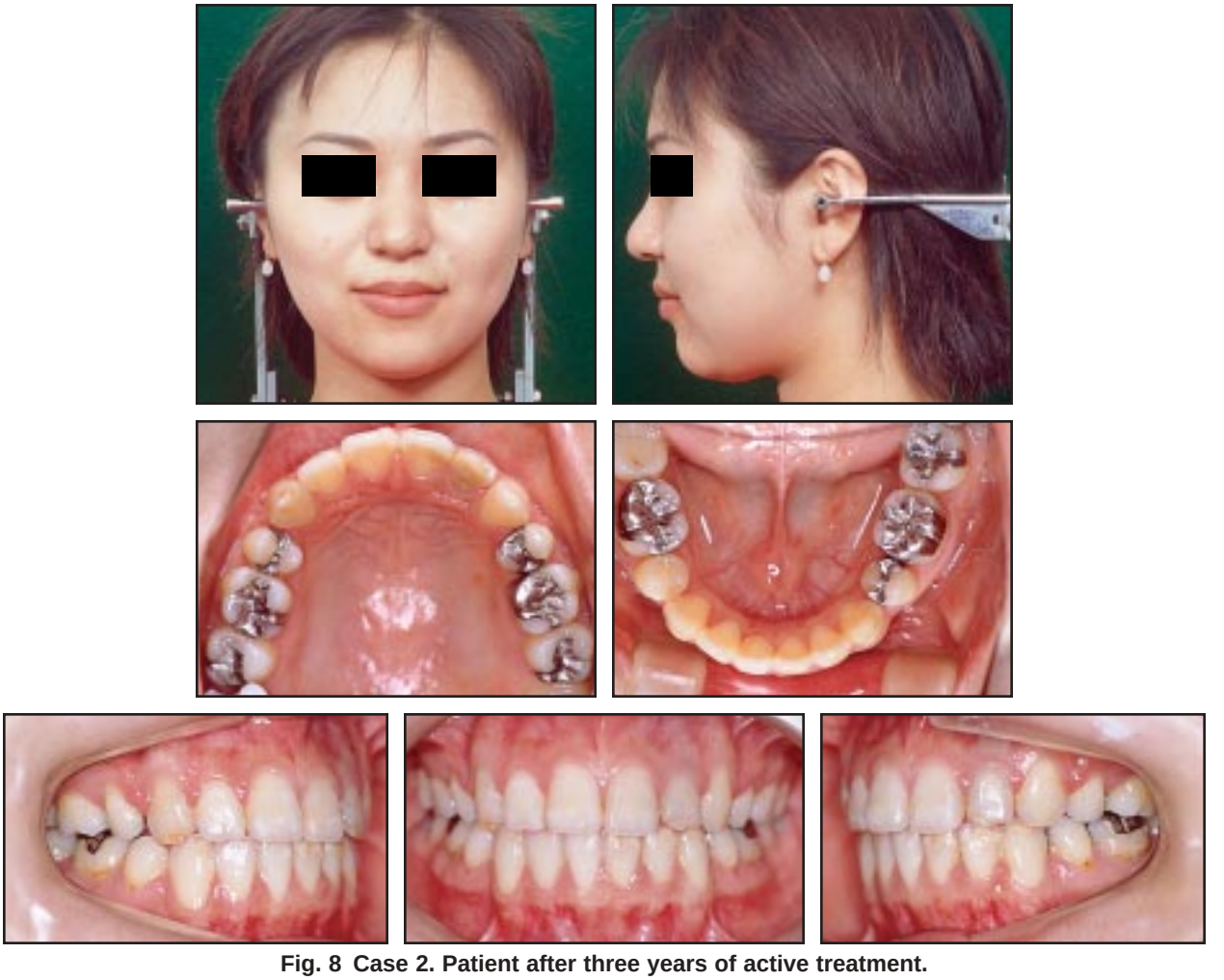

Fig. 8 Case 2. Patient after three years of active treatment.

Case 3

A 24-year-old female presented with a Class II malocclusion due to early extraction of the maxillary second premolars, which had been in palatoversion (Fig. 9). She had a mesially rotated maxillary left central incisor, and her

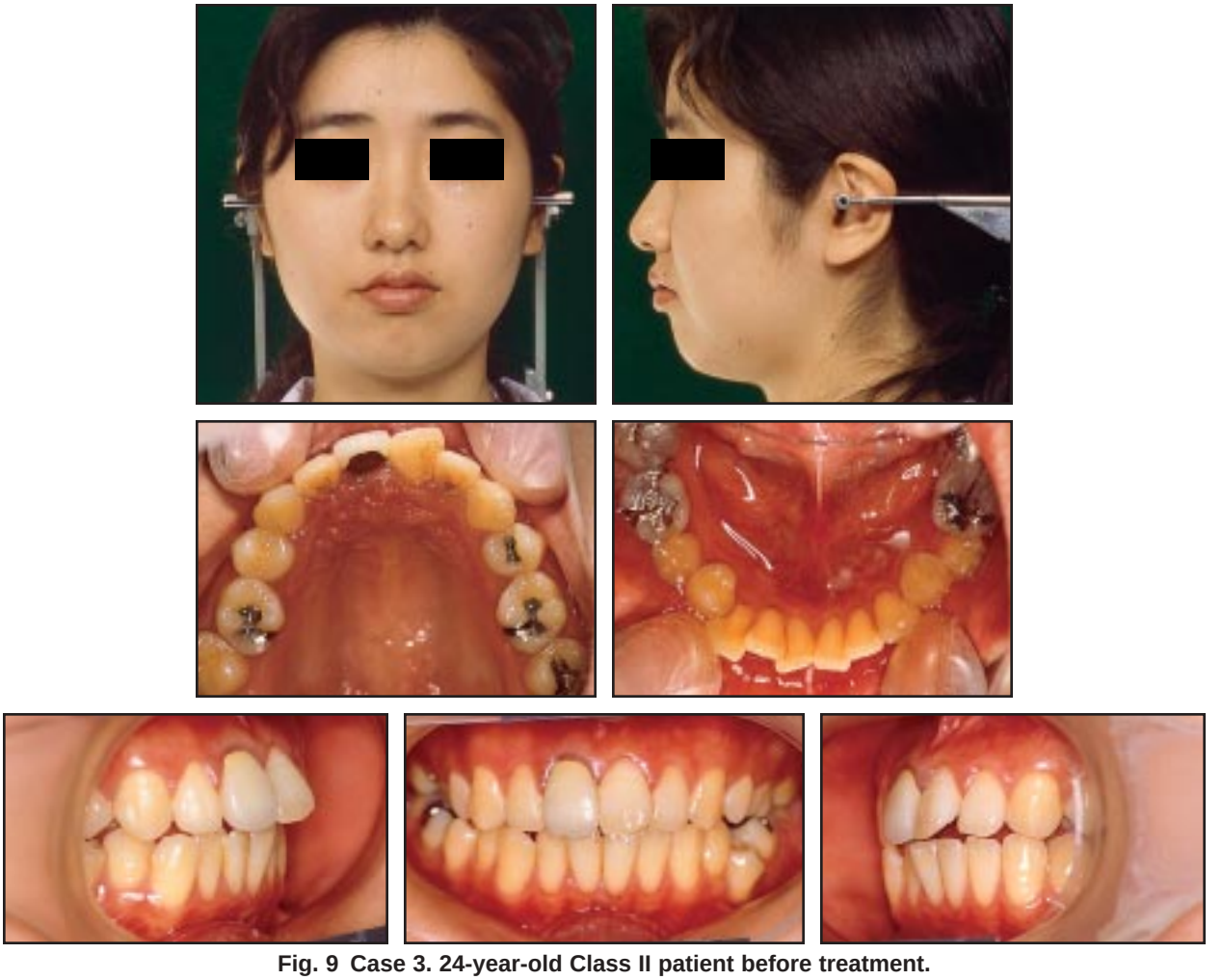

Fig. 9 Case 3. 24-year-old Class II patient before treatment.

Fig. 10 Case 3. A. Continuous mandibular leveling archwire (continued on next page).

Fig. 10 (cont.) B. Continuous wires in both arches after six months of maxillary molar distalization. C. Space closure with intramaxillary elastics.

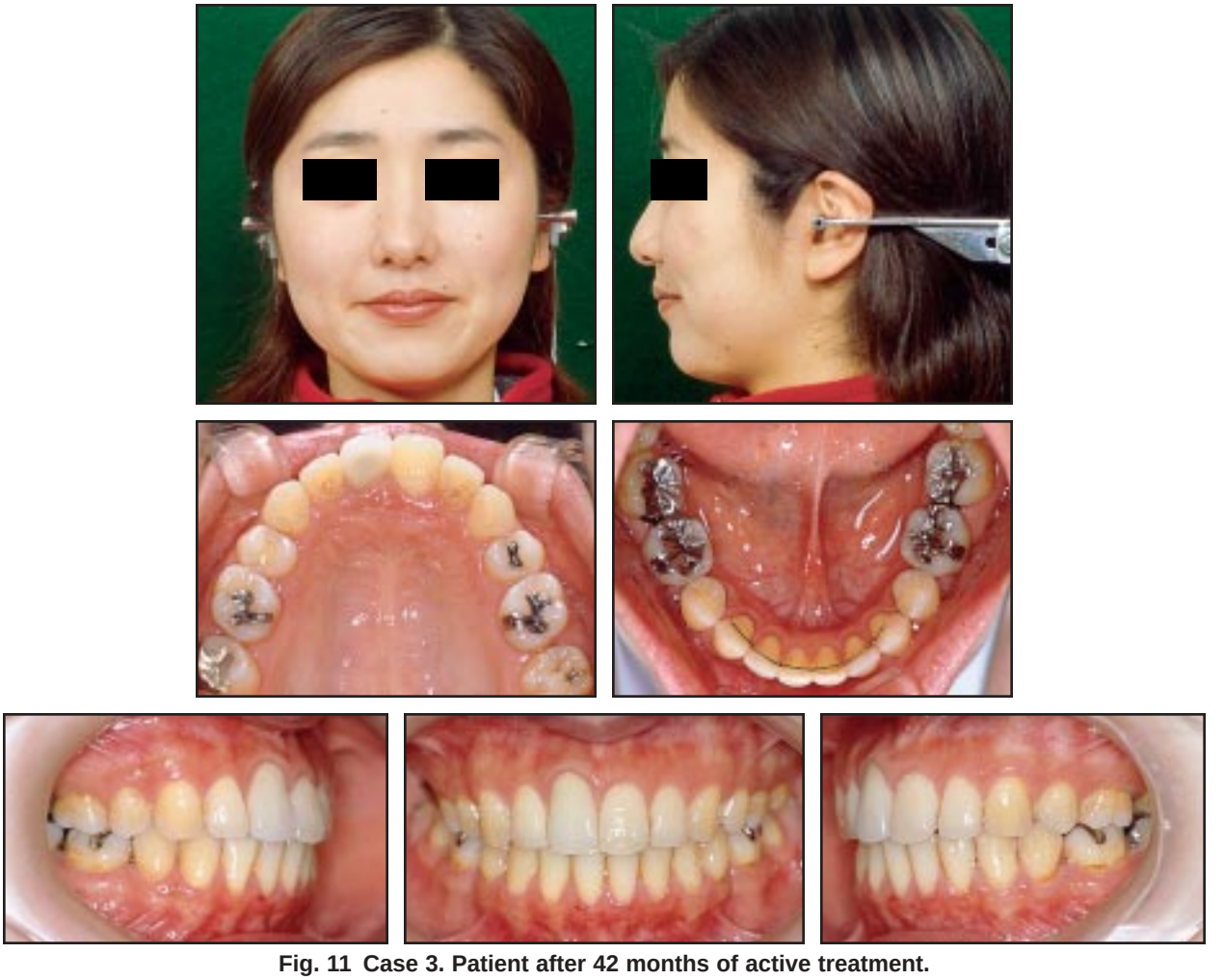

Fig. 11 Case 3. Patient after 42 months of active treatment.

mandibular left second premolar was in infralabioversion.

The maxillary second molars and mandibular second premolars were extracted. The maxillary first molars were banded and pushed distally with headgear to establish a Class I molar relationship. Brackets were then bonded to the mandibular teeth for leveling (Fig. 10A). Six months later, after some distal movement of the maxillary molars had been achieved, brackets were bonded to the maxillary teeth (Fig. 10B). A Quad Helix*** was placed three months later to correct rotations of the maxillary first molars, with headgear worn to prevent undesirable mesial molar movement. Canine retraction and space closure were carried out with sliding mechanics and intramaxillary elastics (Fig. 10C).

Fixed appliances were removed three and a half years after the beginning of active treatment (Fig. 11).

Discussion

Although the polymer archwire is able to exert enough force to move a tooth, the force diminishes more rapidly than it would with metal wires.[5] To overcome this disadvantage, we replaced the wires at shorter intervals (every two to three weeks during the leveling stages). The appliance's self-ligating brackets reduce the chairtime required for archwire changes and, combined with the patient's saliva, minimize the friction between wire and brackets, improving the efficiency of sliding mechanics.

This system has been under trial in our department for more than 10 years. The cases shown here took longer than they might have with conventional appliances, but because they were among the first to be treated with the QCM appliance, some trial and error was involved. The appliance is so inconspicuous, however, that the patients were highly pleased with their appearance during treatment. Some of their friends did not even realize they were wearing braces.

Our newly developed organic polymer maxillary retainer wire is another esthetic device made from the QCM wire.[6] All these polycarbonate appliances are appropriate for use in patients who are allergic to metal.

REFERENCES

1. Sergel, H.G.: Psychologie der Erwachsenenbehandlung, Fortschr. Kieferorthop. 51:8-13, 1990.
2. Talass, M.F.: Case Report: Optiflex archwire treatment of a skeletal Class III open bite, J. Clin. Orthod. 26:245-252, 1992.
3. Talass, M.F.: Practice building with clear wire mechanics, Clin. Impress. 1:10-14, 1992.
4. Oogisi, S.: Characteristics of section, in *Structural Mechanics*, ed. T. Naito, Kashima, Tokyo, 1991, pp. 140-152.
5. Hazel, R.J.; Rohan, G.J.; and West, V.C.: Force relaxation in orthodontic arch wires, Am. J. Orthod. 86:396-402, 1984.
6. Sa'do, B.; Nakata, S.; Morishita, T.; and Nakasima, A.: New, esthetic organic polymer maxillary retainers, J. Clin. Orthod. 35:322-324, 2001.