The Anterior Biteplane Nightguard for Neuromuscular Deprogramming

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Referring dentists often consult orthodontists about the appropriate types of nightguards for patients with TMJ dysfunction. The standard full-coverage, flat-plane splint is often found to be ineffective (Fig. 1), but the use of an anterior biteplane splint may cause the buccal segments to overerupt, thereby opening the bite.

Both Sicher[1] and Scott[2] stated that "when there is a battle between muscles and bone, muscles always win." In TMJ dysfunction, the cartilaginous and bony components that suffer are the condyle and the fossa, which are connected to the soft-tissue temporomandibular disc and ligaments. TMJ patients fall into two groups: those with internal joint pathology, including disc damage and displacement, and those with only neuromuscular dysfunction, including muscle fatigue and spasm.[3] Internal joint pathology is commonly accompanied by neuromuscular hyperactivity and anterior stretching of the retrodiscal tissues.[4] While the prognosis is guarded for patients with internal joint or disc pathology,[5,6] it is good for patients with only neuromuscular dysfunction.[7]

TMD affects both adults and children,[8,9] with females accounting for 70% of the cases in all age groups.[10] Prevalence rates as high as 46% have been found in children[11-15]; the condition is often due primarily to occlusal interferences,[16] for which orthodontic treatment is generally effective.[17] In both children and adults, psychological stress is often associated with clenching and grinding, which can lead to TMJ dysfunction. Personality[18] and genetic influences[19] may be involved in a triggering mechanism for bruxism. TMJ parafunction has also been linked to emotional disorders, irritability, and sleep problems in children. Relaxation techniques and psychotherapy may be helpful in reducing stress or altering the patient's reaction to stress.[20] Finally, inappropriate head posture during extended computer use may contribute to TMD in some cases, where physical therapy may be indicated. Once neuromuscular hyperactivity has produced a deep overbite, spontaneous reversion to a normal overbite generally will not occur, and orthodontic correction of the overbite has a strong tendency to relapse.

TMJ parafunction results primarily from stresses in the central nervous system, with dental interferences such as crossbite playing a secondary role. The neural stresses are analogous to a windstorm in which one grabs a flagpole for stability. The patient clenches and grinds the teeth together in an attempt to achieve stability and comfort, which can result in mandibular overclosure and severe dental attrition (Fig. 2A). Neuromuscular forces can be as much as three times greater than regular chewing forces, reaching 100lbs in the buccal regions. This causes compression of the retrodiscal tissues and, potentially, anteromedial displacement of the disc (Fig. 2B). The disc can be damaged by flattening, development of adhesions, or chronic inflammation of the surrounding tissues. If the condition is left untreated, degenerative arthritis can ensue.

Symptoms of TMJ dysfunction—clicking, crepitus, joint and muscle pain, and headache—can be debilitating, causing the patient to lose time from work or school and creating family problems that may compound the stress in a vicious cycle. Many patients turn to long-term use of anti-inflammatory and analgesic medications, but these often bring insufficient relief. A standard flat-plane, full-coverage splint (Fig. 1B) can sometimes dissipate the parafunctional forces and permit healing of the joint and recovery of the elastic retrodiscal tissues, helping to correct the disc displacement. Moreover, the

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Fig. 1 A. Adult patient with TMJ dysfunction involving clicking and severe pain. Chronic bruxism resulted in deep overbite and moderate attrition of lower incisor enamel. B. Standard full-coverage, flat-plane acrylic splint showing deep wear from clenching and grinding. TMJ dysfunction persisted even after three months of full-time wear. C. Anterior biteplane nightguard (ABPN) worn full-time for three months, followed by long-term night-only wear. Full relief of pain was achieved, with no orthodontic treatment.

condyle and fossa have shown great adaptive capability in primate studies of splints that increase the vertical dimension.[21-23] Such an appliance may not be appropriate over the long term, however,[24] nor is it ideal for all patients, especially if clicking, crepitus, and pain persist. Flat-plane splints are bulky; their interference with speech makes them generally unsuitable for daytime wear, and their multiple contact points make them relatively difficult to insert and adjust.

Anterior Biteplane Splint

Patients with neuromuscular hyperactivity associated with TMJ dysfunction are good candidates for therapy with an anterior biteplane nightguard (ABPN, Fig. 1C). In a comparative study of conservative treatment methods for TMJ dysfunction, this type of appliance produced the greatest amount of symptom relief (84%).[25] In contrast, only 41% relief was obtained with reassurance and counseling, which may be partially explained by the

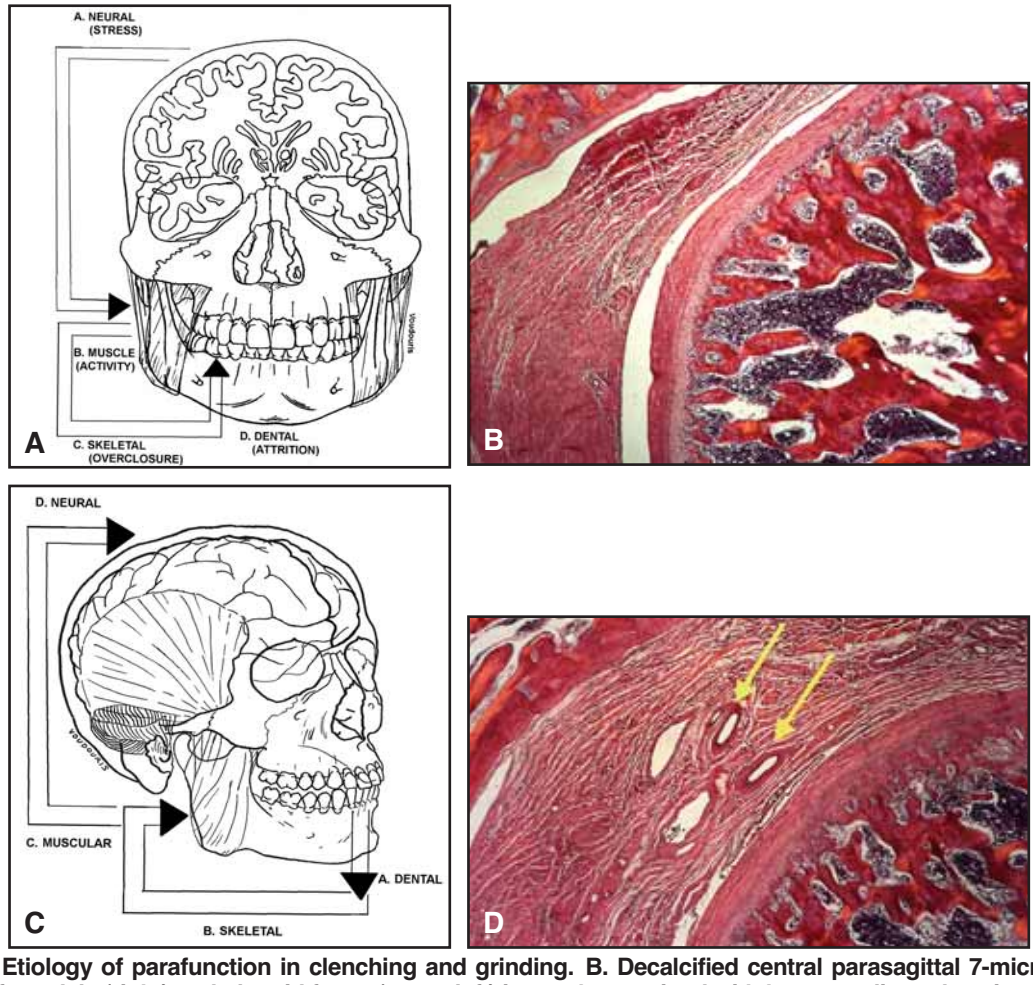

Fig. 2 A. Etiology of parafunction in clenching and grinding. B. Decalcified central parasagittal 7-micron cross-section of condyle (right) and glenoid fossa (upper left) in monkey, stained with hematoxylin and eosin and viewed with polarized light, showing compression of retrodiscal tissues (magnification 3×). C. Effect of ABPN on parafunction. D. Engorgement of large blood vessels (arrows) in retrodiscal tissue following condylar decompression.

placebo effect.[26,27] The ABPN stimulates a jaw-opening reflex, especially during sleep, that rotates the overclosed mandible in a clockwise direction, reducing neuromuscular activity and allowing reeruption of the buccal segments (Fig. 2C). Decompression of the retrodiscal tissue leads to engorgement of its large blood vessels, which promotes healing and regeneration of the tissue and thus the correction of disc displacement (Fig. 2D). Although ABPNs are not generally indicated for the correction of internal joint problems, they can protect the dentition from the consequences of parafunction and increase the vertical dimension. Prosthodontic and orthodontic studies have demonstrated that such an increase in the vertical dimension can reduce neuromuscular activity.[28-31]

Regardless of patient age, an ABPN is preferable to a standard flat-plane splint in patients with neuromuscular hyperactivity (ideally, with orthognathic or prognathic facial types); mandibular overclosure with normal-to-deficient lower anterior facial height; and moderate-to-deep overbite with impingement and dental attrition. In such cases, a flat-plane splint will be ineffective in producing enough of a jaw-opening reflex to increase the vertical dimension. Because this type of splint has multiple contacts on the occlusal surface, the masticatory muscles (masseter, medial pterygoid, temporalis, and lateral pterygoids) continue firing. As the occlusal acrylic wears down, neuromuscular hyperactivity returns and causes an overall intrusive effect on the full dentition, especially the posterior teeth (Figs. 3,4). Therefore, flat-plane bite splints are generally indicated only in patients with less than 25% overbite. In contrast, the ABPN has a single anterior point of contact; its effect is similar to biting down on a steel pen with the central incisors. The jaw-opening reflex that results in clockwise rotation of the overclosed mandible increases the vertical dimension and permits passive or active posterior dental eruption.[21,32] The ABPN also exerts a light intrusive force on the upper incisors that can help correct the deep overbite.

In summary, the ABPN is the best choice under the following conditions:

- Good facial crown-to-lip relationship and full crown display on smiling
- Excessive freeway space
- Excessive overjet
- Severe dental attrition
- Recurrence of TMJ symptoms after use of a flat-plane splint

Bite-block appliances without anterior contacts are indicated in open-bite cases to intrude the buccal segments.

ABPN Design and Fabrication

Anterior biteplanes are easier to construct and adjust than flat-plane splints because they generally do not require major occlusal adjustment between the second molars. A bite registration is usually taken at a 10% overbite, along with a lower impression for mounting. An acrylic ball with supporting metal mesh is placed in the central incisor contact area, extending at least to the incisal edges, or beyond if necessary. The acrylic should be

Fig. 3 8-year-old patient with history of severe clenching associated with TMJ dysfunction, leading to severe dental attrition and premature decay in buccal segments, as well as deep overbite. Note shearing of mamelons of newly erupted incisors.

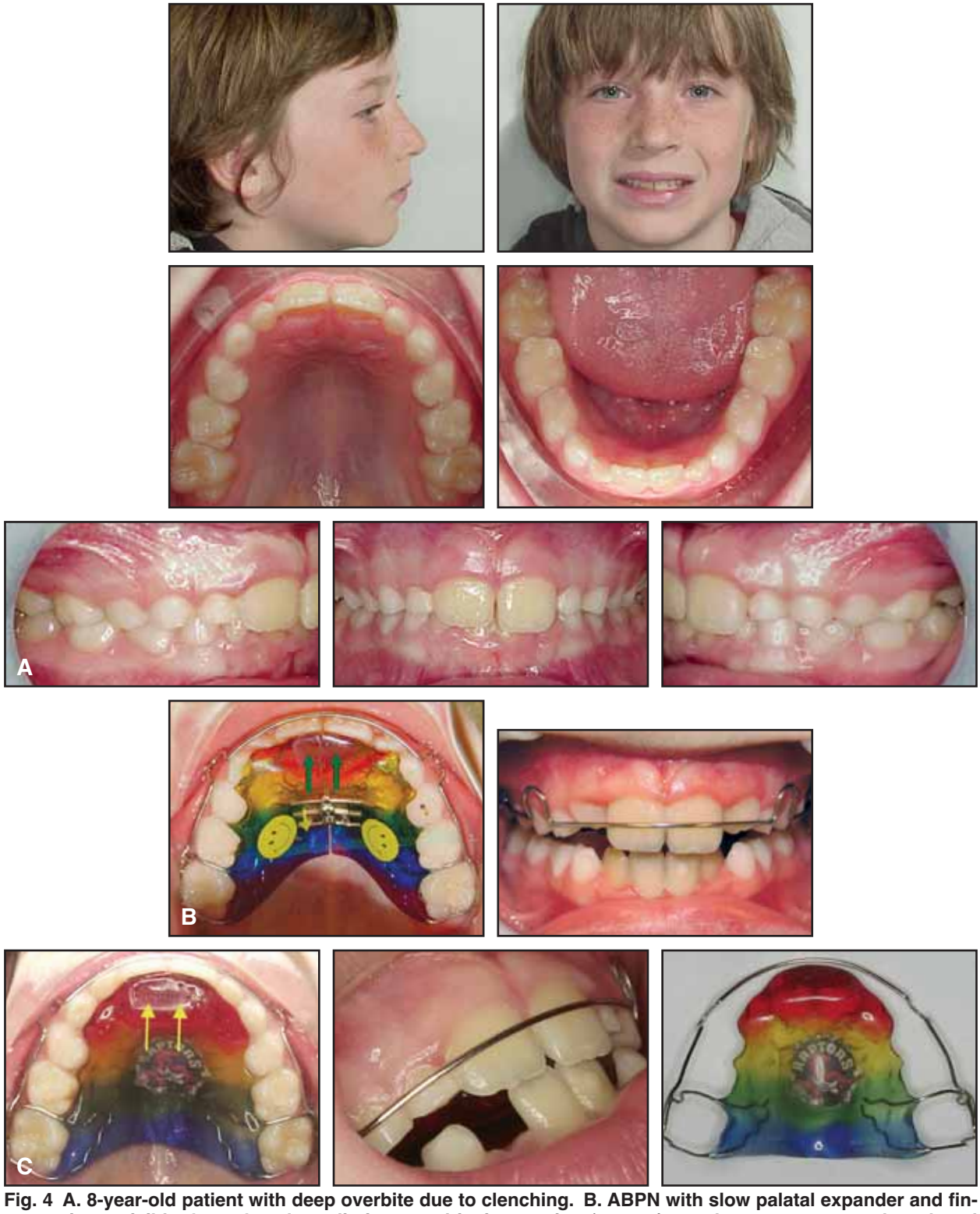

Fig. 4 A. 8-year-old patient with deep overbite due to clenching. B. ABPN with slow palatal expander and finger springs, visible through red acrylic in central incisor region (arrows), used to correct secondary dental interferences. C. New ABPN with similar positioning of acrylic (arrows) worn only at night after palatal expansion for ongoing protection against clenching and grinding.

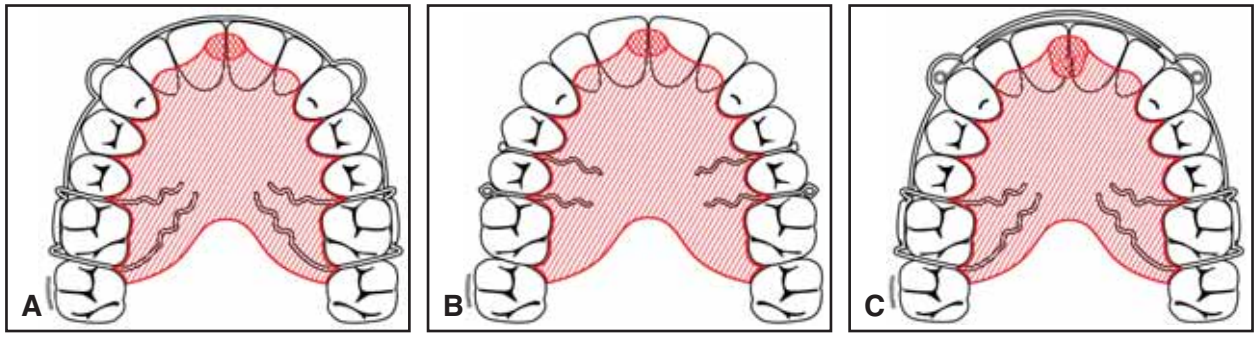

Fig. 5 A. Standard ABPN design, showing thick acrylic ball with supporting metal mesh at central incisor contact point, along with Hawley-Wilson loops and Adams clasps for additional retention. B. "Invisible" ABPN design, showing half ball clasps distal to first premolars, replacing Hawley wires, and diamond-shaped clasps distal to second premolars, facilitating insertion and removal. C. "Automatic Hawley" design, permitting retraction of maxillary incisors in cases of significant overjet, with biteplane extended posteriorly to allow trimming as overjet decreases.

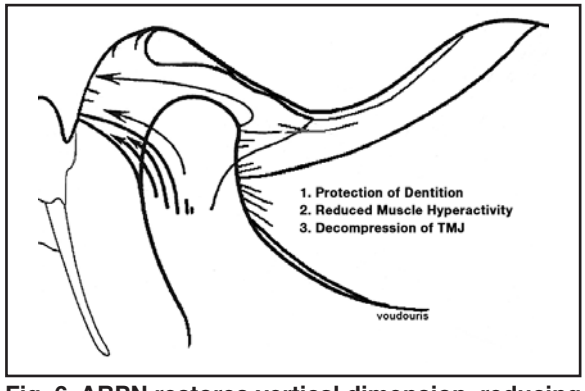

Fig. 6 ABPN restores vertical dimension, reducing neuromuscular hyperactivity and allowing decompression of TMJ components. Premature disc displacement is improved by posterosuperior pull of elastic retrodiscal tissues (arrows).

slightly concave on the palatal side to allow for anterior guidance (Fig. 5A). Anterior Hawley-Wilson loops and Adams clasps at the first molars provide additional retention. In adults, ball clasps can be used instead of the Hawley-Wilson wires in the premolar regions to make the ABPN virtually invisible; the top half of each ball clasp is removed to prevent long-term gingival impingement (Fig. 5B). Special diamond-shaped clasps behind the second premolars are angled slightly away from the gingivae to facilitate insertion and removal. In cases with significant overjet, an "automatic Hawley" version of the ABPN permits automatic retraction of the maxillary incisors (Fig. 5C). The biteplane is extended posteriorly so that it can be trimmed back as the overjet is reduced. The palatal surface of the upper incisors must be kept free of plaque during retraction to prevent gingival inflammation from the palatal acrylic as the incisors are retracted against the gingiva. If secondary dental factors are involved in the TMJ dysfunction, an ABPN can be used with auxiliary devices such as finger springs or miniscrews to achieve minor dental movements (Fig. 4B).

Diagnosis and Treatment Planning

Treatment of a patient who presents with signs and symptoms of TMJ dysfunction should begin with a good medical and dental history to identify the etiological components. The orthodontist should take note of mouthbreathing habits, maxillary constriction, overbite, overjet, midline, crossbites, and missing teeth. Dental complications can produce functional lateral or anterior mandibular shifts that cause further grinding of the teeth and exert displacing forces on the TMJs. The correction of these factors will reduce neuromuscular hyperactivity and allow the TMJ regions to decompress.

The patient should be informed at the initial consultation that a nightguard may not be completely effective, depending on the degree of TMJ damage and patient compliance, and that arthroscopic surgery to remove soft-tissue adhesions, disc plication, and other surgical procedures are available to supplement the nightguard treatment. Ideally, the condyle and fossa should be evaluated tomographically and, if necessary, with transcranial and panoramic radiography. The position of the soft-tissue disc can be evaluated by arthroscopy.

The neural component of the TMJ dysfunction should be addressed with relaxation training, and the muscular component with moist heat and appropriate exercises. The skeletal dysplasia and dental malocclusion can then be corrected with an anterior biteplane and orthodontic treatment, with or without surgery. Even though a patient with excessive lower anterior facial height has a guarded prognosis, short-term use of an anterior biteplane is appropriate because such patients generally require surgery, such as a Le Fort I and mandibular advancement.

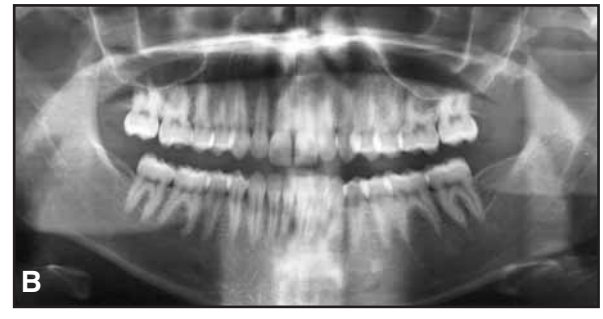

Fig. 7 A. Young female patient with Class II, subdivision left malocclusion, deep overbite, and severe TMJ pain and clicking from clenching and joint parafunction. B. Panoramic radiograph suggests forward positioning of right condyle in fossa and condylar flattening, confirmed by significant left deviation of mandibular midline before treatment and significant improvement after treatment (continued on next page).

Fig. 7 (cont.) C. Initial insertion of ABPN, to be worn full-time for three months; patient was seen monthly to smooth acrylic and tighten retention clasps. D. Mild reintrusion of posterior buccal segments after transition to night-time ABPN wear, resulting in normal overbite of 25%.

In a patient with deep overbite, the next step is to reestablish the vertical height of the intruded posterior buccal segment and create incisor stop contacts to provide the necessary dental intercuspation and anterior support for incisal guidance during mandibular excursions. The primary goals of the ABPN are to protect the dentition from the effects of continued clenching and grinding, reduce neuromuscular hyperactivity,[22] and decompress the TMJ components (Fig. 6). When the lower incisors contact the acrylic ball on the anterior biteplane, the jaw opens and neuromuscular forces are lessened (Fig. 7).

This reduction of neuromuscular hyperactivity is critical to establish the proper centric relationship between the condyle and the glenoid fossa before the initiation of orthodontic or prosthodontic treatment (Fig. 8). The ABPN is generally worn full-time for three months before orthodontic treatment, and should be continued throughout treatment in a patient with deep overbite due to an extreme curve of Spee and mandibular overclo-

sure[24] (Fig. 9). Any wear on the anterior acrylic can be smoothed with a straight acrylic bur, and the Adams clasps can be curled toward the first molars for improved retention. When maxillary anterior retraction is required, the palatal aspect of the acrylic in the upper incisor region should be trimmed about 1mm at each five-week appointment, with the trimming bur angled 45° posteriorly. Because of the anteroposterior width of the contact ramp on the shiny surface, there is generally no need to rebuild the acrylic. In patients with overjet who require retraction, the ramp should be constructed with extra anteroposterior width in anticipation of the acrylic trimming (Fig. 5C).

Fig. 8 A. Adult patient with neuromuscular hyperactivity, TMJ clicking and pain, deep overbite, insufficient crown display, and mandibular overclosure, resulting in protrusive chin position. Cephalogram shows counterclockwise rotation of mandible and reduced anterior facial height, along with dental attrition from severe overbite (continued on next page).

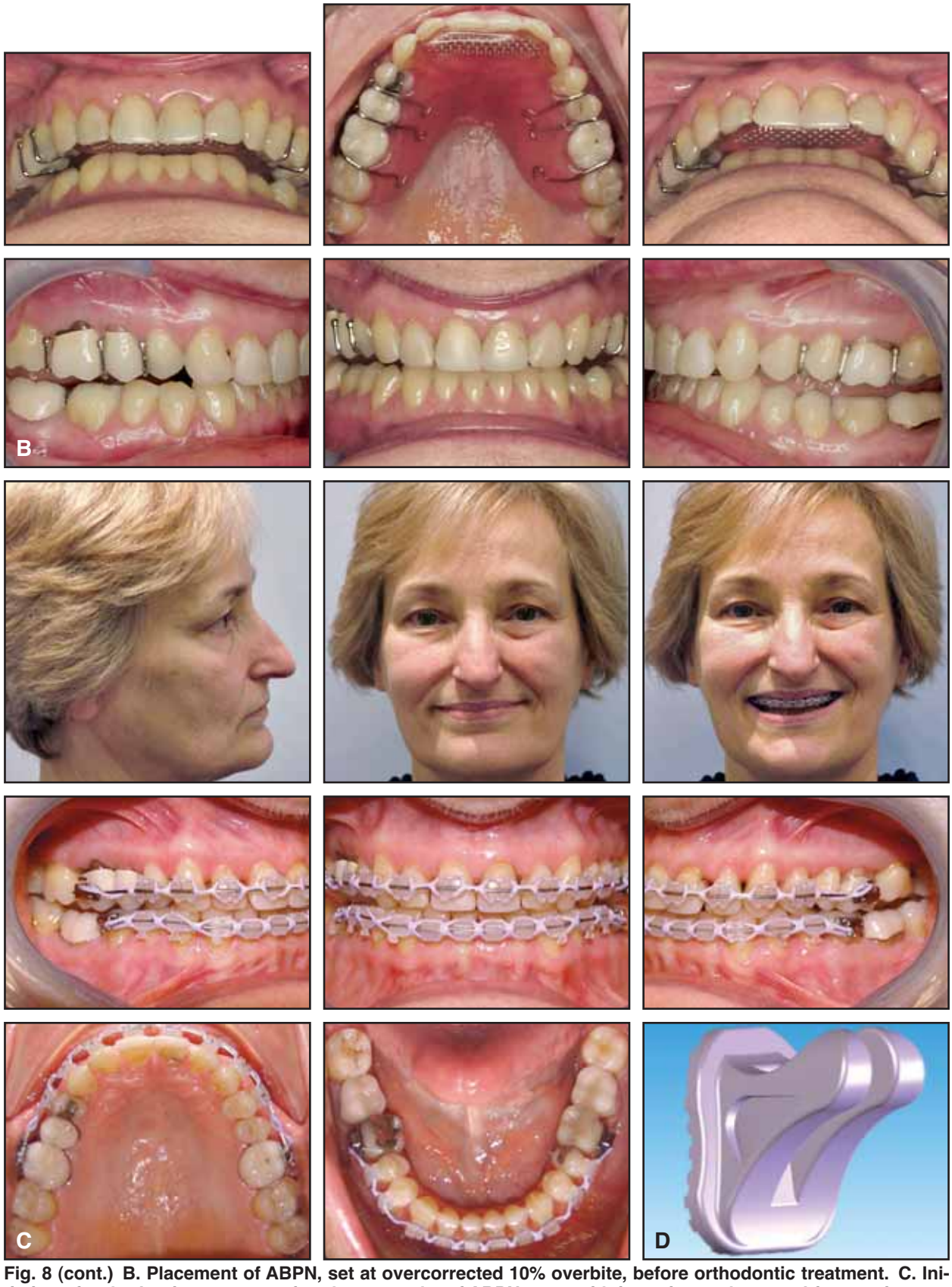

Fig. 8 (cont.) B. Placement of ABPN, set at overcorrected 10% overbite, before orthodontic treatment. C. Initiation of orthodontic treatment after three months of ABPN wear, with intrusion arches used for passive correction of deep overbite and active eruption of buccal segments. D. Gnathological bite supports bonded to maxillary central incisors to protect them from lower ceramic brackets.

Gnathological Bite Supports

Fixed biteplanes are increasingly being employed to treat neuromuscular hyperactivity associated with deep overbite. A new gnathological bite support (GBS) can be bonded to the palatal surfaces of the maxillary central incisors to exert an effect similar to that of an ABPN (Fig. 8D). Special features include incisal curvature for anterior guidance, a vertical slot for ease of placement and debonding, a "comfort curve" at the protrusive palatal end to protect the tongue from irritation, and a self-cleaning gingival cutout curvature to reduce plaque accumulation. Because the GBS is bonded, it can be worn full-time throughout orthodontic treatment.

Although the bite supports can be placed in children with deep overbites who do not require posterior stabilization, they should ideally be used in combination with full-bracketed orthodontic treatment. In the mixed dentition, orthodontic treatment should be delayed until at least three months after GBS bonding to enable complete neuromuscular deprogramming. If there is any concern about short-term incisor flaring, the palatal acrylic ABPN should be used, since its larger surface area allows it to absorb more of the anterior impact of the occlusion. The ABPN is definitely the appliance of choice if no orthodontic treatment is planned. In growing children, if the Adams clasps seem likely to intrude the permanent molars, they can be moved to the premolars, or looser-fitting ball clasps can be used.

Another fixed method of opening a deep overbite is the addition of composite resin* on the mesiobuccal cusps of the lower first molars. These composite ramps must be removed within three to six months, however, because they have been observed to intrude the mandibular first molars in cases of long-term neuromuscular hyperactivity.

Retention

A new ABPN, made with a bite registration at an overcorrected 10% overbite, is used during retention for continued restriction of neuromuscular hyperactivity.[21,22] One year of full-time post-treatment wear, followed by long-term night-time wear, is recommended to maintain the vertical dimension. When the ABPN is worn only at night, the maxillary and mandibular buccal segments will tend to intrude during the day, but will reerupt at night. The patient should be instructed to remove the retainer in the morning, brush it with toothpaste (especially on the palatal side), rinse it, and place it in the retainer case. At night, it can simply be rinsed prior to insertion.

With appropriate bite registration of the retention ABPN, there should be no concern about overeruption of the buccal segments (Fig. 7C,D). The overbite will approach 20% as the anterior acrylic wears down and patient compliance with long-term use declines. This protocol yields excellent long-term results in most patients with TMJ dysfunction.

Conclusion

The primary etiological component of TMJ dysfunction associated with clenching and grinding is neural, with possible secondary dental influences. Not all TMJ patients are good candidates for standard flat-plane splints. In cases of neuromuscular hyperactivity and severe TMJ dysfunction with more than 25% overbite, an ABPN can achieve neuromuscular deprogramming, thus promoting eruption of the buccal segments and restoration of the vertical dimension. ABPNs are easy to fabricate and can be used before, during, and after orthodontic and prosthodontic treatment for long-term protection of the dental enamel and maintenance of treatment results.

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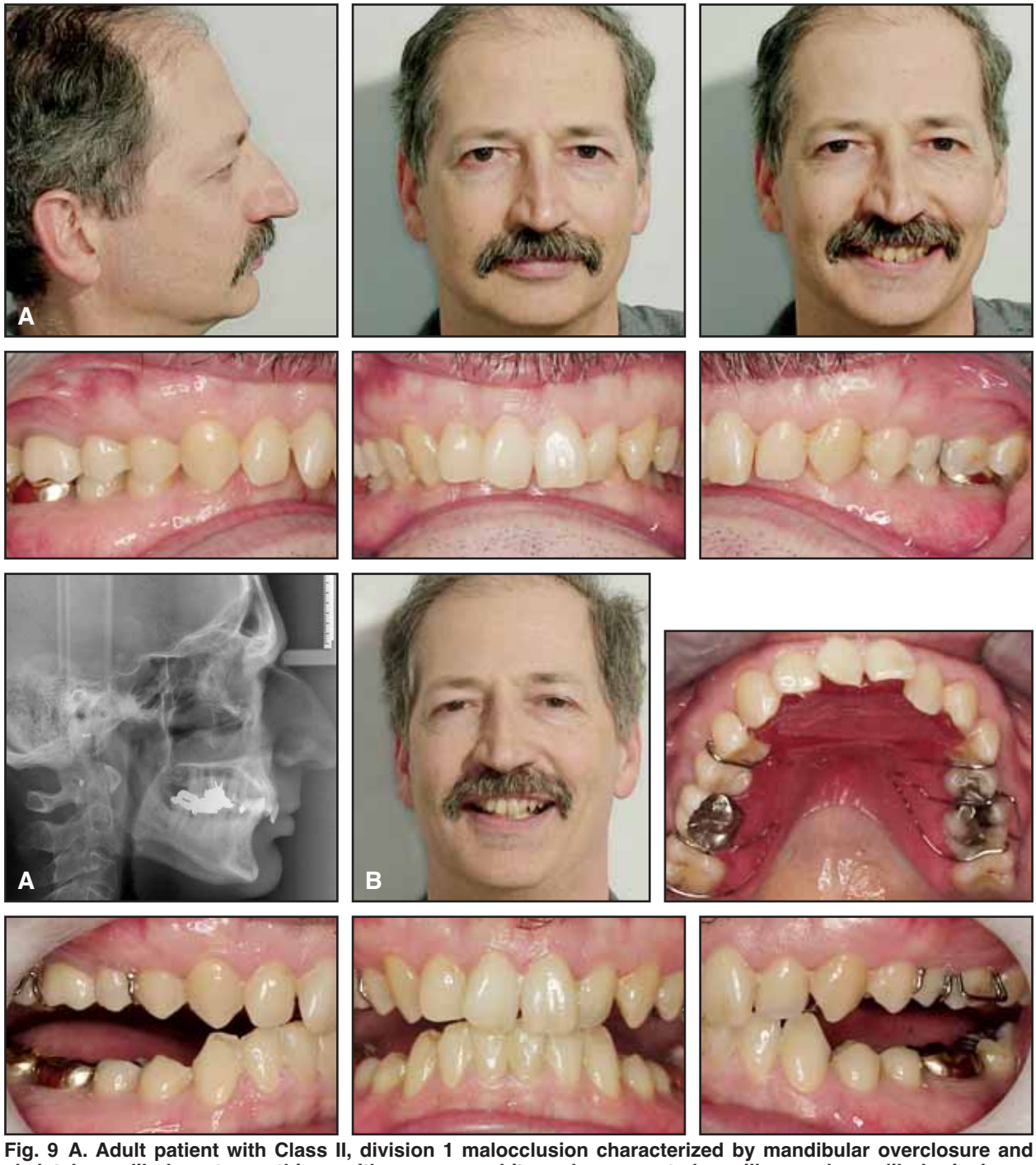

Fig. 9 A. Adult patient with Class II, division 1 malocclusion characterized by mandibular overclosure and skeletal mandibular retrognathism, with severe overbite and overerupted maxillary and mandibular incisors. B. Dramatic correction of deep overbite with "invisible" ABPN worn full-time throughout orthodontic treatment (continued on next page).

Fig. 9 (cont.) C. Study cast shows severe palatal impingement due to initial overeruption of maxillary and mandibular incisors and intrusion of buccal segments, associated with anterior gingival recession and periodontal pockets. Second phase of orthodontic treatment included intrusion of maxillary and mandibular incisors and reeruption of buccal segments with self-ligating bracket system and vertical, box-shaped buccal elastics. Significant improvement in overbite was achieved with brief series of .014", .016", and .018" nickel titanium archwires.*** D. ABPN deprogrammed neuromuscular hyperactivity by restoring vertical dimension.**

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