Splinted mandibular protraction appliance

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Abstract

Advancement of mandible rather than tooth movement is an ideal treatment for the correction of Class II malocclusion resulting from mandibular retrusion. In growing patients, forward repositioning of mandible by mandibular repositioning appliances is considered as a treatment of choice. Correction of mandibular retrusion by the conventional mandibular protraction appliances (MPAs) is mainly due to dento-alveolar changes and by altering the design of original MPAs, these limitations were minimized. The modified design enhanced the mandibular growth and contributed for the better skeletal correction of Class II malocclusion as compared to the conventional MPAs. This article highlights the design and fabrication of a splinted MPA for the correction of Class II malocclusion due to mandibular retrusion and also describes a patient managed by this appliance.

Keywords: Class II malocclusion, fixed functional appliance, splinted mandibular protraction appliance

Introduction

Advancement of mandible rather than tooth movement is a more appropriate treatment for patients with Class II Division I malocclusion resulting from mandibular retrusion. In growing patients, forward repositioning of mandible by mandibular repositioning appliances is considered as a treatment of choice.[1-3] In recent pasts, mandibular protraction appliances (MPAs) were found as reliable and efficient rigid fixed functional appliances for the correction of mandibular retrusion.[4-8] Among all MPAs, MPA-IV is not only more effective in correcting Class II malocclusion but also is much more practical to construct, easy to clinical management and comfortable for the patient.[9] Since MPA-IV is a fixed appliance, full-time patient compliance is also more predictable. However, it is observed that the correction of Class II malocclusion by MPA-IV was largely due to dento-alveolar changes rather than skeletal changes.[8] Thus, by altering the original design of MPAs, these limitations could be minimized. This article highlights the design and fabrication of splinted MPA and a patient treated by the appliance.

Components and design

The appliance basically consists of maxillary and mandibular acrylic splints to which T-tubes and modified mandibular rods are attached. The appliance consists of various components like T-tubes, modified mandibular rods, Hyrax screw, maxillary first molar tubes with round headgear tube, molar pins, mandibular circular loops and maxillary and mandibular acrylic bite splints. In the buccal aspect of maxillary splint at permanent first molar region, molar tubes are incorporated and to which T-tubes are attached by molar pins. A Hyrax screw is used to stabilize the maxillary splint and for the expansion of the maxillary arch in patients with a constricted maxilla. At the canine region of mandibular splint on either side, circular loops are placed and to which modified mandibular rods are attached.

Clinical management

First patient visit (impression making and bite registration)

During first appointment, accurate bubble free maxillary and mandibular alginate impressions are made, and a protrusive wax bite is obtained by registering the desired anterior repositioning of the mandible. During wax bite registration, skeletal midlines are aligned using dental midlines as a reference point. Impressions are then poured in stone plaster, and bubble or imperfections are removed. The models are inserted into the wax bite registration and checked, and then mounted on a simple hinge articulator using the advanced wax bite.

Fabrication of appliance

Two T-tubes are made with 0.040” stainless steel tubes as described by the Coelho Filho.[10] The length of the longer
tube should be sufficient and depends on the amount of bite jumping. Usually, 40 mm length is sufficient. Molar pins (ball pins) are 0.032” stainless steel wire with a soldered ball on one side and are used as upper molar locking pins. The ball pin is inserted into the smaller section of the T-tube and then bent with finger pressure until it is parallel with the longer tube [Figure 1a]. Hyrax screw is adapted for the stabilization of the upper appliance, it also beneficial where expansion of the maxilla is required. Mandibular rods are made with 0.036” hard stainless steel wire. About 3 inches of 0.036” hard stainless steel wire is taken, and a small circular loop is bent at right angle to the end of the wire with the help of 139 heavy pliers. Two small mandibular circular loops are made with 0.032” hard stainless steel wire [Figure 1b]. On either side of the circular loop, about 1 cm wire tag is kept for the retention of the loop in the lower acrylic bite splint.

In the maxillary working model, Hyrax screw is adapted. Then acrylic bite splint is fabricated extending from last erupted molar to the canine region on either side. The acrylic coverage extended from free gingival margin on the buccal surface of the posterior teeth and canine and runs over the occlusal surface of the teeth ending at the free gingival margin on the lingual surface. At the permanent first molar region, molar tube is incorporated in the acrylic block in such a way that the long axis of the round headgear tube remains parallel to the occlusal plane and also parallel to midpalatal raphe [Figure 1c]. The gingival hook of the molar tube is kept intact for better retention of tube in the acrylic.

In the mandibular model, mandibular circular loops are kept just distal to the canines on either side. The loops are kept buccal to the arch, and tags are adapted over the occlusal surface. The acrylic coverage extended from free gingival margin on the buccal surface of the anterior teeth and canine and runs over the occlusal surface of the teeth ending at the free gingival margin on the lingual surface. The appliance may be approximately 0.5 mm in thickness [Figure 1d].

After fabrication of maxillary and mandibular acrylic splint, the length of T-tubes and mandibular rods are determined and then cut to fit. From the maxillary and mandibular models both splints are removed and then trimmed and polished. The occlusal surfaces of the maxillary and mandibular splints must be flat for optimum contact while chewing. Now the appliance is ready for cementation in the patient’s mouth.

**Second patient visit**

Maxillary and mandibular acrylic splints are cemented with glass ionomer cement. Than molar pins are inserted into first molar headgear tubes of the maxillary tube from the distal aspect and the ends of the ball pins are bent occlusally. Free ends of the mandibular rods are inserted into the T-tube, and the loop portion of the mandibular rod is inserted into the mandibular circular loop. At this position length of the mandibular rods are rechecked, and any excess are cut. The loops of the modified mandibular rods on either side are closed with the help of 139 heavy pliers.

Next, the patient is given a face mirror and asked to open the mouth as wide as possible. If by chance during wide opening the mandibular rods disengaged from T-tubes, the patient is shown how to reinsert the mandibular rods into T-tubes by holding the mouth wide open.

**Patient instruction**

The patient is told that it will take several days to get used to the appliance. During this period, the jaw muscles may become tired and sore with time. However, the patient will become increasingly comfortable. The appliance may rub against the cheeks causing irritation. This problem is temporary and can be prevented by placing orthodontic wax or chewing gum over the connections of appliance until the irritation passes. Patient may experience some difficulty during chewing. Thus, soft diet for initial few days may helpful. The patient is cautioned to avoid hard and sticky foods. The patient should be instructed to maintain proper oral hygiene. The patient should be called after 7 days and then in every 4 weeks to check progress and to inspect the appliance.

**Reactivation of appliance**

Reactivation of appliance can be done by a short section of unused 0.040” tube over each mandibular rod. Advancement
can be repeated at 2–3 months intervals until desired amount of mandibular repositioning obtained.

Advantages of splinted mandibular protraction appliance
The splinted MPA is designed to overcome so many problems of conventional MPAs. As the splints are cemented to the teeth, it can be used during the mixed dentition period where comprehensive orthodontic treatment with full arch bonding is not possible. As the Hyrax screw is attached in the maxillary acrylic splint, simultaneous correction of the transverse maxillary basal arch deficiency can be carried out. The occlusal acrylic coverage in the maxillary and mandibular arch prevents eruption of the posterior teeth and thus it is very much suitable in the patients with downward and backward mandibular rotation. As the splints are cemented to all the teeth, and the whole arch is stabilized as a single unit, this reduces the likelihood of dento-alveolar effects for the correction of Class II malocclusion.

Disadvantages of splinted mandibular protraction appliance
Although the splinted MPA has many advantages over the conventional MPAs, however as the appliance is bulky it can lead to chewing and speech problems for initial few days. As the splints are cemented to the dental arches, it can prevent the eruption of permanent teeth during the mixed dentition stage. There is a possibility of looseness of the maxillary, and mandibular acrylic splints and fracture of the T-tubes are there with this design. Also, there are hazards to the patients from enamel decalcification and iatrogenic enamel fracture on debonding of splints.

Case Report
A 12-year-old female patient reported with the chief complaint of forwardly placed upper front teeth and small lower jaw. Family history was not contributory. Extra-oral examination revealed apparently symmetrical face, convex profile and potentially competent lips. Temporomandibular joints were asymptomatic with the normal range of mandibular movements. On intra-oral examination, she was in early permanent dentition with full complement of teeth up to second molars in each quadrant, constricted maxillary arch, Class II molar relationship bilaterally, deep bite (70%) and 12 mm of overjet. Her clinical visual treatment objective was positive. Cephalometric analysis revealed Class II skeletal base due to mandibular retrusion, hypodivergent mandibular growth, up-righted mandibular incisors and proclined maxillary incisors. Various cephalometric parameters are described in Table 1.

The treatment plan involved expansion of the maxillary arch and anterior repositioning of the mandible. Splinted MPA was used for the correction of maxillary constriction and mandibular retrognathism. Maxillary and mandibular working impressions were made, and wax bite registration was done with one-step mandibular advancement. The sagittal and vertical displacements of the mandible were 7 mm and 4 mm respectively during wax bite registration. The splinted MPA was fabricated, and the finished appliance was checked and cemented to the maxillary and mandibular arches. The Hyrax screw was opened ¼ turn twice daily for 15 days. The patient was advised not to chew hard food and to maintain proper oral hygiene. The patient was reviewed in every 4 weeks and the appliance wearing was discontinued after 7 months. The Class II correction following splinted MPA therapy was retained by an anterior inclined plane and the occlusion was finished with multi-bonded appliance (Roth 0.018” prescription). The skeletal and dento-alveolar changes following treatment is described in Table 1.

Discussion
The overall treatment result was very satisfactory. At the end of splinted MPA therapy, Class I molar and skeletal relationships were achieved. The soft tissue harmony was improved...
The maxillary inter-canine and inter-molar widths were increased by 4 mm each. The correction of Class II skeletal and dental relationship was contributed both by mandibular growth and movement of the maxillary and mandibular dentition. The majority of the molar correction was contributed by the skeletal change whereas the correction of overjet was mainly due to forward movement of the lower incisors and palatal tipping of the maxillary incisors.

There was total 6.49 mm of molar correction and 9.50 mm of overjet correction by the appliance during the period of 7 months. The skeletal contribution for the molar correction was 61.57% and for the overjet correction was 39.47%. However, in contrast to this finding, there was only 38.50% skeletal contribution for the Class II molar and overjet correction by the conventional MPA-IV.

The nature of Class II correction by this appliance was similar to the nature of Class II correction by bonded Herbst appliance. The extension of the acrylic splint in the mandibular arch was up to the second premolars.

**Table 1: Important skeletal and dento-alveolar cephalometric parameters**

| Parameters                  | Norms mean±SD | Pretreatment (29/10/2010) | Postfunctional (12/06/2011) | Posttreatment (07/10/2012) |
|-----------------------------|---------------|---------------------------|----------------------------|---------------------------|
| SN length (mm)              | 65.3±3.00 mm  | 68                        | 69                         | 70                        |
| SNA (°)                     | 81.3±3.59°    | 79                        | 80                         | 81                        |
| Maxillary length (mm)       | 44 mm         | 45                        | 46                         | 46.5                      |
| SNB (°)                     | 77.7±3.46°    | 75                        | 79                         | 80                        |
| Mandibular length (mm)      | 49 mm         | 71                        | 75                         | 76                        |
| ANB (°)                     | 3.64±1.60°    | 4                         | 1                          | 1                         |
| Wits (mm)                   | 0 mm          | 3                         | 0.5                        | 0.5                       |
| FMA (°)                     | 26.00±4.5°    | 18                        | 22                         | 23                        |
| SN-GoGn (°)                 | 33.00±6.03°   | 25                        | 29                         | 30                        |
| Y-axis (°)                  | 61.80±3.4°    | 54                        | 57                         | 57                        |
| U1-SN (°)                   | 104.86±6.43°  | 120                       | 109                        | 112                       |
| U1-NA (°) and (mm)          | 23.50±6.79° and 5.90±2.87 mm | 42 and 10 | 29 and 7 | 33 and 7 |
| U1-Palatal plane (°)        | 65.00±5.00°   | 59                        | 65                         | 62                        |
| IMPA (°)                    | 100.00±6.44°  | 98                        | 107                        | 112                       |
| L1-NB (°) and (mm)          | 27.77±5.94° and 6.36±2.41 mm | 22 and 4 | 30 and 6.5 | 33 and 7 |
| Upper lip-E-line            | –2 to –3 mm   | 1                         | 1                          | 1                         |
| Lower lip-E-line            | –1 to –2 mm   | –1.5                      | 1                          | 0                         |
| Nasolabial angle            | 99.00±8.00°   | 90                        | 95                         | 97                        |
| Lip strain                  | 0.00±0.00 mm  | 5                         | 1.5                        | 2                         |

SD: Standard deviation; IMPA: Incisor mandibular plane angle; FMA: Frankfort mandibular plane angle
As a result, the molars erupted during the MPA treatment and caused FMA and SN-GoGn to increase by 4° each. However in the subjects with downward and backward rotation of the mandible, the acrylic should be extended up to the last erupted molars to prevent the posterior tooth eruption. The major undesirable effect of functional appliance therapy is forward movement of the lower dentition. In the present case, lower incisors were moved 3 mm forward during the splinted MPA treatment [Figure 6b]. The limited extension of lower acrylic splint up to the second premolars could be responsible for such movement. Although the present case report showed many benefits of splinted MPA over conventional MPAs, but a well-designed case–control study is required to confirm these benefits.

**Conclusion**

The splinted MPA is an efficient fixed appliance and can be used for the treatment of Class II malocclusion due to retrognathic mandible. The skeletal contribution for the correction of Class II malocclusion is more by this splinted MPA as compared to the conventional MPAs.

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