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Extending the Use of a Diagnostic Occlusal Splint to overcome Existing Lacunae of Vertical Dimension Transfer in Full Mouth Rehabilitation Cases

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Abstract Full mouth rehabilitation involving an increase in vertical dimension of occlusion presents lacunae in accurate and definite transfer of diagnosed and verified vertical dimension of occlusion, biologically compatible with the stomatognathic system. Currently, vertical dimension to be incorporated within the restorations is done arbitrarily by adjustment of vertical pin of articulators in the laboratory, which is graduated in difference of a minimum of 1 mm. This article describes an innovative and extended use of a diagnostic occlusal splint to overcome the lacunae. The technique utilizes the diagnostic occlusal splint to transfer vertical dimensions at various stages of mounting of working casts thereby incorporating the clinically verified vertical dimensions in the final prosthesis. The technique involves splitting the diagnostic occlusal splint into anterior and posterior half. On the posterior half further centric relation records are then made. At the same time the technique described eliminates errors incorporated as a result of frequent use of face bow index record and/or arbitrary adjustment of the articulator as well as the difference between clinical determination of vertical dimension and the arbitrary laboratory adjustment on the articulator.

Keywords: *occlusion, attrition, amelogenesis imperfecta, diagnostic splint*

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1. Introduction

Full mouth rehabilitation treatment has taken leaps and bounds in the past decade, especially in clinical conditions like amelogenesis imperfecta (AI), which is a genetically determined and rare enamel mineralization defect reported by Spokes [1] in 1980 as "hereditary brown teeth." Amelogenesis imperfecta was characterized as a clinical entity in 1945. Its clinical manifestations, histological appearance and genetic pattern are characterized by their heterogeneity. A widely used classification system for AI is based on genetic inheritance, histopathology and specific clinical dental characteristics. [2] Amelogenesis imperfecta is an enamel defect that can be inherited in a sex-linked or autosomal manner. [3] In general, the inheritance pattern is usually autosomal dominant, autosomal recessive or X-linked. Within affected families, there is an extremely variable clinical appearance of enamel hypoplasia, hypocalcification or hypomaturation, depending on which stages of enamel formation are involved [4].

Dental features associated with AI include: quantitative and qualitative enamel deficiencies, pulpal calcification, taurodontism, root malformations, failed tooth eruption, impaction of permanent teeth, progressive root and crown resorption, congenitally missing teeth, unaesthetic appearance, dental sensitivity and attrition. [5-9] AI is rare with a prevalence of 0.06:1,000 in a study of 4 to 12 years old in the United States [10] and 0.1:1,000 in children between 6 and 18 years old in Israel, [11] a prevalence of 0.2:1,000 is reported among 3 to 19 years old in the western part of Sweden [12] and 1.4:1,000 in all children between 0 and 19 years old in the northern part of Sweden. [13] Restoration of these defects is important not only because of esthetic and functional concerns [14-18] but also because there may be a positive psychological impact for the patient. [19,20,21] Both deciduous and permanent teeth are affected and the disorder may create the unaesthetic appearance, dentinal sensitivity and severe attrition. Numerous treatments have been described for rehabilitation of amelogenesis imperfecta in adults [22,23,24] as well as in children. [25,26,27,28] The treatment options range from stainless steel crowns and composite restorations in children, [29] extractions of all of the teeth and treatment with complete dentures, [30,31,32] porcelain labial veneers for the hypomaturation pattern of amelogenesis imperfecta, [33] Overdentures, [35,36], and fixed Prosthodontics [37-43]

Depending on the extent of the deformity treatment in adults usually includes full mouth rehabilitation that may involve complete fixed prosthodontics or a combination of fixed and removable prosthodontics. Ideally patients with amelogenesis imperfecta in adults fall in the category where occlusal vertical dimensions are compromised and therefore the treatment in such cases becomes more complex. Diagnostic splints or provisional restorations itself are used to assess the tolerance of the patient to changes in occlusal vertical dimensions (OVD). [44] For any full mouth rehabilitation case, that involves an increase in vertical dimension of occlusion, the amount of increase is accomplished on the articulator with adjustment of vertical pin on the articulator which is graduated in millimeters. Increase in vertical dimension of occlusion is sensitive as there is less margin of error and any minor increase within a fraction of a millimeter can prove detrimental to the stomatognathic system. This article in the form of a clinical case report describes a clinical technique that allows a clinician to establish the exact amount of vertical increase in the final restoration without any arbitrary adjustment on the articulator.

2. Clinical Case Report

2.1. History and Examination

A male patient, aged 32 years was referred to the Department of Prosthodontics from department of oral medicine diagnosed with clinical condition of amelogenesis imperfecta. However, the chief complaint of the patient was related to dissatisfaction with the size, shape and shade of the existing dentition (Figure 1). A thorough dental, medical and social history was critically recorded. Family history revealed that the patient's mother and his brother were having similar dental problems with variable severity and different clinical picture. Clinical examination of the patient revealed receding hair line, pigmented spots on forehead, thick upper lip, hypomobile upper lip, stained natural dentition, good oral hygiene index, fair gingival and periodontal index, generalized labial, lingual and occlusal wear of natural teeth, generalized gingivitis with localized periodontitis, short clinical crowns, generalized spacing, absence of gingival and occlusal embrasures, occlusal plane discrepancy (maxillary and mandibular occlusal plane not aligned parallel to each other due to supra eruption and tooth wear), apical periodontitis in relation to maxillary anterior teeth (diagnosed clinically by presence of tenderness and radiographic evidence of disruption of lamina dura) and few carious lesions. Radiographic examination revealed impacted left and right mandibular third molars, impacted maxillary third molars with little or no crown formation and a periapical lesion in relation to mandibular right second molar (Figure 2). Clinical data necessary to plan rehabilitation included determination of interocclusal distance (6 mm), existing vertical dimension of occlusion (5.5 cm by using a modified Niswongers method), closest speaking space, the coincidence of centric occlusion with centric relation (centric occlusion coincided with centric relation), occlusal plane discrepancy, oral hygiene index, evaluation of mandibular movements, the patient's attitude towards extensive dental treatment and need for root canal therapy.

For systematic and sequential treatment, preliminary impressions were made in irreversible hydrocolloid (Jeltrate Alginate, Fast Set; Dentsply Intl, York, Pa) and then poured in high strength dental stone (Elite Model; Zhermack, Badia Polesine, Rovigo, Italy). The diagnostic casts were duplicated and one set was mounted on a semi adjustable articulator (Hanau Widevue, Waterpik, Ft Collins, CO, USA) using an arbitrary face bow (Hanau Spring bow) and centric interocclusal record using bimanual palpation method (Take 1, Kerr, Romulus, MI, USA). The articulator was then programmed by using a protrusive interocclusal record for horizontal condylar guidance and lateral guidance was calculated using the Hanau's formula. The mounted diagnostic casts were evaluated for molar and canine relations, anterior guidance, overjet, overbite, vertical overlaps in posteriors, cuspal alignment of all posteriors, occlusal plane and functional occlusion in centric and eccentric positions.

Figure 1. Intra oral view of existing dentition. Note severely treated teeth with a decreased vertical dimension of occlusion

Figure 2. OPG showing associated dental anamolies

Once the prognosis of successful rehabilitation was established by a prosthodontist, a multidisciplinary team comprising a psychologist, oral radiologist, preventive dentist, periodontist, dental hygienist, oral pathologist, endodontist, dental technician and ceramist were consulted. A treatment plan was devised which included determining the tolerance of patient towards an increase in vertical dimensions using a removable occlusal splint, oral hygiene maintenance program, surgical crown lengthening, endodontic therapy, psychological counseling of the patient for better understanding of his role in long term success of the restorations, fluoride prophylaxis, restorations of carious teeth and finally fixed restorations of all the remaining natural teeth with an increased

vertical dimension. The patient was educated about the duration, his role and the outcome of the entire treatment and informed consent was obtained. The treatment planned was delivered in four stages as follows:-

STAGE 1: During this stage, the amount of increased vertical dimensions that would be biologically tolerated by the patient was determined through the use of a permissive splint (occlusal). Mock preparation on diagnostic cast along with the establishment of the anticipated occlusal plane was determined after conventional wax up. A putty index of the wax patterns was fabricated. Once the desired esthetic results were analyzed, an occlusal splint made of clear heat cure acrylic resin (DPI-Heat cure, Dental products of India Ltd, Mumbai, India) was prepared on another set of casts which were also mounted on a semi adjustable articulator. The initial thickness of the occlusal splint was kept to 1 mm which was gradually increased to a thickness of 3 mm. The patient was able to tolerate an increase in vertical dimension of up to 3 mm without any signs of discomfort (Figure 3). During this period, the patient's condition and functions, such as muscle tenderness, discomfort of temperomandibular joint, mastication, range of the mandibular movements, swallowing and speech was evaluated. Counselling of the patient with a psychologist in determining and improving his mental attitude towards extensive dental treatment was also done at this stage. Education and motivation were required to increase confidence and allay patient's fears and apprehensions.

Figure 3. Diagnostic occlusal splint with increased vertical dimension of occlusion

STAGE 2: In the second stage, the patient underwent an oral hygiene maintenance program and surgical crown lengthening of all natural teeth. An increase of 1 mm or more in posterior teeth and 2.5 to 3 mm increase in anterior clinical crown height was established (Figure 4). This was followed by a fluoride prophylaxis in the form of topical fluoride. Increase in crown length was considered necessary despite the patient finally wearing crowns with increased vertical dimensions. The crown lengthening was done to incorporate an aesthetic uniform gingival line and enhance placement of margins within maximum thickness of the enamel on the labial and lingual side. Endodontic and restorative treatments were completed in this stage (Figure 5).

STAGE 3: Before the third stage was started, all the mouth preparations done prior to prosthetic phase were evaluated. Mandibular anterior teeth were prepared first to receive porcelain fused to metal restorations. Gingival retraction was done and then final impressions were made using a combination of light and medium body addition polyvinyl siloxane material (Reprosil, Dentsply/Caulk; Milford, DE, USA). The mandibular cast obtained after tooth preparations, was then mounted on the semi adjustable articulator using a centric interocclusal record. Wax patterns were fabricated on mandibular individual dies with the help of putty index, which was fabricated after diagnostic wax up was done in the second stage. Temporary crowns made of tooth colored heat cure acrylic were processed from these wax patterns (DPI-Heat cure, Dental products of India Ltd, Mumbai, India). The temporary crowns were cemented using eugenol-free zinc oxide cement (PreVision Cem; Heraeus Kulzer).

Figure 4. Surgical crown lengthening of natural teeth

Figure 5. Endodontic treatment of all natural teeth

Figure 6. Mandibular anteriors cemented in place

The final restorations for mandibular anterior teeth were cemented using zinc phosphate cement (Figure 6). After cementation of lower anterior restorations, an alginate impression was made of mandibular dentition and was poured with dental stone. This cast, then replaced the existing mandibular cast present on the articulator on which temporary restorations were fabricated previously.

The mounting of mandibular cast was done using the existing occlusal splint, which was modified by removing the anterior part of the splint. The split splint was then placed on the maxillary cast mounted on the articulator and evaluated for its fit. Bite registration wax (Metrowax; Metrodent Ltd, Huddersfield, West Yorkshire, UK) was adapted over the two portions of the split splint to stabilize as well as make interocclusal record on the splint. The bite registration wax was softened and a new centric relation record was made using this innovative method (Figure 7 and Figure 8). This procedure not only allows mounting of mandibular cast with a centric relation record, but also once mounting is done, removal of bite registration wax from the splint ensures that the same vertical dimensions of occlusion have been restored on the articulator. All subsequent mountings have used the same technique, thereby eliminating the errors as a result of mounting costs through the use of face bow index record and our arbitrary adjustments of vertical pin on articulators. Maxillary anterior teeth were then prepared and subsequent procedures were followed, including mounting of new prepared casts using the same split splint which still maintains the established vertical dimensions. Wax patterns were fabricated for maxillary crowns and after metal and porcelain trial, definitive restorations were cemented in the maxillary anterior region with zinc phosphate cement (Figure 9).

Figure 7. Diagnostic occlusal splint placed back in centric to make a centric record

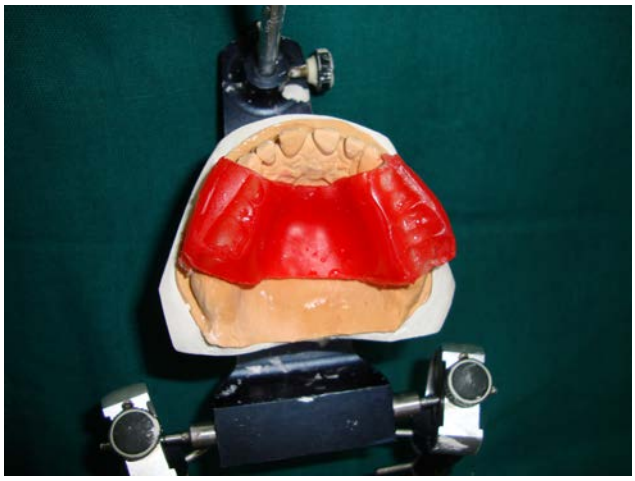

Figure 8. Centric record carried on splint used to mount future casts

The anterior guidance between the maxillary and mandibular restoration was determined by the guidance that the articulator had been set at the time of diagnostic wax up. Anterior guidance was also verified by the putty index, which was made earlier, immediately after diagnostic wax up. Right side maxillary and mandibular teeth were then prepared and their impressions were poured in die stone and the casts were mounted in the same way alternately. The occlusal surface of all the posterior teeth was developed in metal with three point occlusal contacts. The definitive restorations were cemented using zinc phosphate cement on both right and left sides (Figure 10 and Figure 11).

Figure 9. Maxillary anteriors cemented in place with established anterior guidance

Figure 10. Full mouth rehabilitation with porcelain fused to metal crowns

After the initial trial cementation of restorations, final cementation was done and the patient was once again counseled by prosthodontist as well as a periodontist for future follow up. The patient was highly satisfied with the final outcome of his treatment.

STAGE 4: The final phase included periodic follow up on the treatment in entirety. The follow up protocol for full mouth rehabilitation involving multiple single crowns included evaluation of efficacy of oral hygiene measures after 1 week, 1 month and thence every three months. During the follow up appointments plaque, gingival and periodontal indices were recorded and managed accordingly. The problem that arose during the first few months of full mouth rehabilitation was porcelain chipping in relation to maxillary right canine at the level of cingulum which was subsequently repaired. The patient has been successfully rehabilitated with porcelain fused to

metal individual crowns since last five years (Figure 12) and reports regularly for follow ups.

Figure 11. Extra oral view of amelogenesis imperfecta affected natural dentition after rehabilitation

Figure 12. OPG at post follow up

3. Discussion

In 1984, Turner [45] classified the treatment of a severely worn dentition by the amount of the loss of VDO and available space to restore. His classification and conventional treatment, which includes raising VDO with multiple crown-lengthening procedures, have been widely used up to present. However, the etiology of tooth wear is multifactorial and clinical controlled trials of restorative and Prosthodontic approaches are limited in quantity and quality. In addition, lack of evidence regarding the long-term outcomes of treatment methods and material cause difficulty in clinical decision-making. [46] Because of these unclear guidelines, adhesive strategy, that is more conservative and reversible, is increasing. [44,47] However the conservative adhesive resin treatment could not be used for this patient. The quality and the quantity of the dentition, patients socioeconomic status, patient education, esthetics, restoration and maintenance of oral functions for a long period of time indicated the use of porcelain fused to metal restorations in this case.

The time period for wearing an occlusal splint and/or provisional crowns with increased vertical dimensions ranges between 3 weeks to six months. [48-52] The effectiveness of the occlusal splint is determined clinically. The purpose in this case has though been magnified, but its primary purpose was to evaluate the amount of increase in vertical dimensions that could be tolerated. Patients with AI along with occlusal wear of the permanent dentition tend to tolerate increases in vertical dimensions very well, provided the increase is within the physiological limits of the orofacial musculature and mandibular opening. In cases where vertical dimensions of occlusion encroach upon the relaxed contractile length of the muscle fibers, especially those of muscles of mastication, any treatment involving an increase in vertical dimensions is doomed to fail. [53] Clinical determination of adequate interocclusal distance and speaking space are good indicators of whether the increase in vertical dimension will be tolerated or not. It is a good exercise that the maximum limit of tolerable increased vertical dimensions is determined as in this case it was found to be 3 mm and the actual increase in the vertical dimensions was not done by more than 2.5 mms. A buffer of 0.5-1 mm or more will always result in better patient compliance. Among the materials available to make the occlusal splint heat cure acrylic resins was preferred to minimize the errors as a result of polymerization shrinkage. Because the splint is modified later and to be used as a template to carry the interocclusal recording material, minimal changes in the splint are desired otherwise errors in the fit and mounting of casts could occur.

Full mouth rehabilitation is not only an extensive restorative procedure, but also economically, psychologically and physically very demanding on the part of the patient. [54] The numbers and duration of appointments to completely prepare the mouth for receiving extensive restorations are many and the patient should understand the benefits of such necessary treatment. Patient counseling before, during and after treatment helped to abolish the factors that could affect the prognosis. Patients resolve, to look good was highlighted in the case history and during subsequent steps of esthetic rehabilitation; the dramatic change in his appearance was appreciated in front of the patient by other clinicians working in the clinic. There was a dramatic increase in enthusiasm of the patient after his permanent anterior teeth were cemented. The patient's cooperation though throughout the treatment was never doubted but there was something new in his will after the anterior teeth were cemented with encouraging comment from other clinicians improved the motivational levels of the patient. One word of caution is that the opinion should be sought only when the prosthodontist is confident of his makeover restorations.

The technique utilizing the existing splint offers the advantage of the exact amount of increase in vertical dimensions to be incorporated as tolerated by the patient. Unnecessary arbitrary adjustment of vertical pin on the articulator is thus eliminated. It is important to mention here that a maximum of 3-4 mm of increase in vertical dimensions has been advised. Therefore, this technique becomes more important in that simple fact that where the range is within 3-4 mm an error of even a small magnitude cannot be afforded. In reality, if increase of 2 mm for a particular patient has been decided then an error as small as 0.5 mm could be disastrous for the stomatognathic system. During the full mouth rehabilitation procedure one needs to frequently mount the maxillary and mandibular casts many times using the face bow index and adjusting vertical pin of an articulator. The above technique also allows the clinician to make interocclusal records directly on the modified splint thereby inheriting stability to the interocclusal record itself.

4. Conclusion

The above mentioned technique allows clinician to transfer the verified vertical dimensions of occlusion through occlusal splint to his final restorations. Care is therefore required to ensure that the diagnostic occlusal splint remains physically and chemically stable throughout the procedure. Proper instructions regarding the fabrication, wearing and maintenance of the occlusal splint are mandatory

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