Seven Keys to Optimize Interdisciplinary Orthodontics

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Orthodontics has always been the discipline that sets the stage for dento-facial esthetics. With the increasing demand for appeal and appearance, orthodontic treatment of adults has been the fastest growing area in the field of orthodontics. In addition to aesthetics, increased awareness of malocclusion, functional benefits of orthodontic treatment, advances in materials, aesthetically pleasing and biomechanically sound appliances, and interdisciplinary treatment philosophy have all played an important role in making orthodontic treatment popular in adult population.

However, in recent years, increased focus on simplified and rapid intervention has created compromises in treatment outcomes. Lack of fundamental diagnosis and systematically sequenced treatment plans are being circumvented by technology and reliance on laboratory assistance. Diagnostic process, essence of treatment planning and biologic basis seem to be diminishing in importance. Often orthodontic treatment can be of significant assistance in periodontally and restoratively compromised patients. The primary goal of orthodontic therapy in such clinical situations is to reduce or prevent excessive periodontal surgery by establishing a physiologic alveolar crestal topography and to establish better occlusal relationships for predictable long-term prosthesis by customized orthodontic tooth movements. This article explains the philosophy and treatment approach that brings together a diverse group of professionals into a cohesive interdisciplinary team to provide treatment strategies for adult patient. It explains existing and new orthodontic, periodontic, surgical and restorative techniques that provide the best possible solution to complex dentofacial problems.

In clinical practice, orthodontic treatment of adults may be somewhat different from that of most adolescents (1). Compared with adolescents, adults are more likely to have dentitions that have undergone some degree of mutilation over a period of time and they may have other problems like missing teeth, restored teeth, periodontally compromised teeth, endodontically involved teeth etc., which demand some alterations in treatment strategy.

In patients with periodontally compromised dentition with significant bone and attachment loss, conventional approach to orthodontic tooth movement does not produce the desired results, as this may lead to increased tipping of teeth (2). Therefore, in such clinical situations, entirely different biomechanical strategies are required for efficient and desired tooth movement (3). Absence of growth potential in adults as opposed to growing patients is another factor that influences the orthodontic treatment strategy to resolve adult malocclusions.

1) Establish organized approach to diagnostic and treatment planning process

To formulate proper treatment plan, clarity in the final treatment and to prevent any complications and confusion, establishing accurate diagnosis is the most important step. The goal of the diagnostic process in an interdisciplinary treatment is to produce a comprehensive but concise list of patient's problems and to incorporate various treatment options into a plan that gives maximum benefit to the patient (4). The orthodontist should:
1) recognize the various elements of malocclusion contributing to the development of a problem. This can be achieved by developing a comprehensive but concise database of useful information derived from patient's history, clinical examination and analysis of diagnostic records (study models, full-mouth radiographs and facial and intraoral photographs; (Fig.1)
2) have comprehensive knowledge of different disciplines of dentistry to generate the pertinent data other than orthodontics,
3) and finally, define the nature of the problem to design a treatment strategy based on the specific needs and desires of the patient.

This database is then well organized in such a way that it gives a systematic description of the patient's problems. The team involved can easily refer to this during the treatment planning process. While arranging the database of a complex dentofacial problem in a systematic manner, if the problem list becomes very extensive, it is advisable to classify the problem list into various areas like orthodontic problem list, restorative problem list and periodontal problem list (Fig. 2).

2) Define treatment goals

In the management of a patient with multiple dental problems, it is extremely important for a clinician to define finishing goals at the beginning of treatment and continue to focus on them till the finishing stage, in order to achieve them with a combination of appropriate orthodontic treatment mechanics, restorations and periodontal procedures. The treatment goals are mainly focused on establishing optimal oral health, aesthetics, good stomatognathic function and long-term stability.

The clinician should be able to visualize the end result before implementing the definitive treatment plan. This requires clearly defined treatment goals that set the direction to the proposed treatment plan. Ideally, interdisciplinary treatment plan should be the one that addresses maximum number of highest priority problems including the chief complaint and optimizes the treatment results with maximum benefit to the patient with less risk involved. Since complex dentofacial abnormalities frequently present multifaceted problem list involving

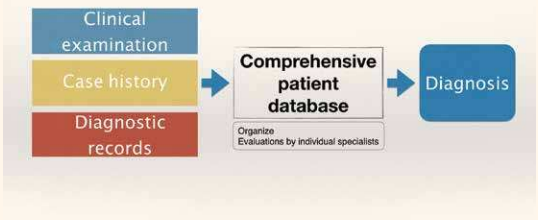

Figure 1: Diagnostic process.

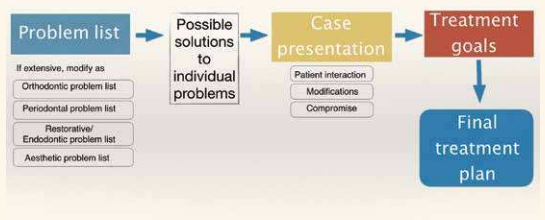

Figure 2: Organized approach to a final treatment plan.

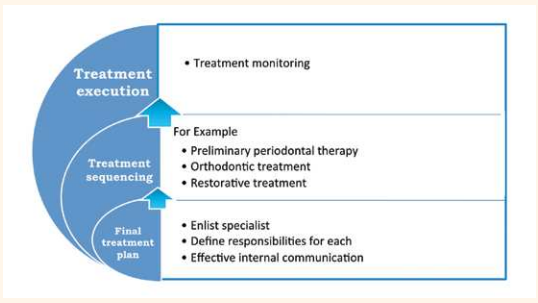

Figure 3: Treatment execution.

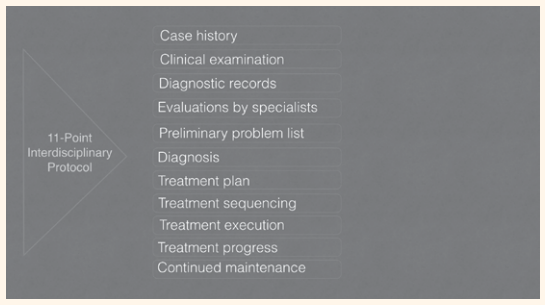

Figure 4: 11-point interdisciplinary treatment protocol.

Figure 5: Tooth position and periodontal health. (A) Gingival impingement due to deep bite causes direct periodontal lesion, (B) Dental crowding leads to accumulation of plaque that causes indirect periodontal lesion, (C) Orthodontic movement of teeth into better bone support, parallelism of roots and differential vertical tooth movement

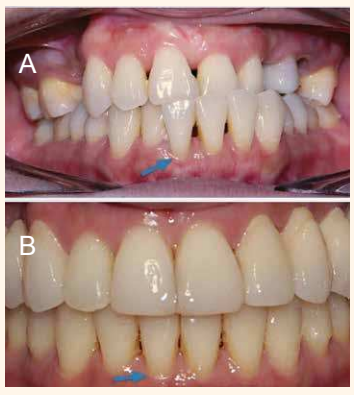

Figure 6: Dental arch crowding as a 'major' periodontal concern. (A) Labially positioned mandibular right central incisor associated with gingival recession. (B) Teeth that are orthodontically moved into areas of better bone support show partial attachment gain.

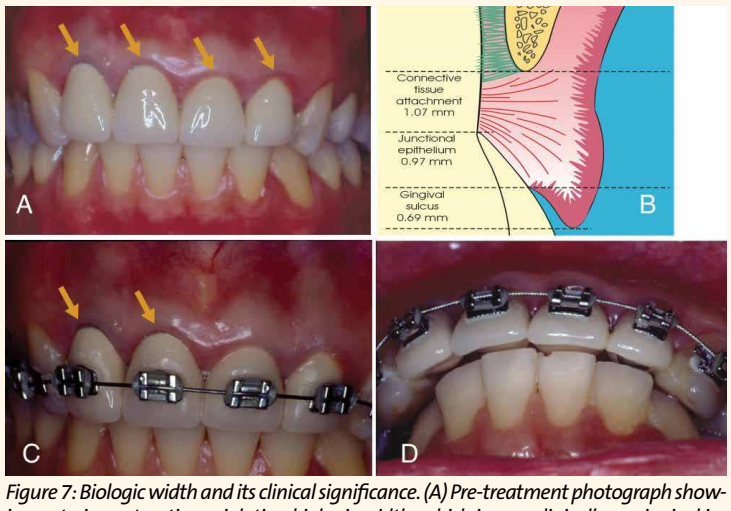

Figure 7: Biologic width and its clinical significance. (A) Pre-treatment photograph showing anterior restorations violating biologic width, which is seen clinically as gingival inflammation and recession. (B) Illustration shows biologic width and its components. Total attachment of 2.04 mm is essential for the preservation of periodontal health. Its components include: mean gingival sulcus depth of 0.69 mm, junctional epithelium measuring 0.97 mm and mean supra-alveolar connective tissue attachment of 1.07 mm. (C) Orthodontic treatment to bring about differential forced eruption of 11 and 12. (D) Restorations are contoured palatally to create interocclusal space to facilitate vertical movement of incisors

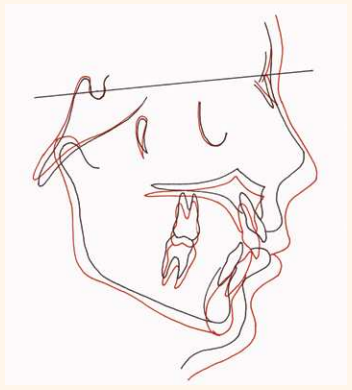

Figure 8: Lateral cephalometric superimposition to determine the status of facial growth

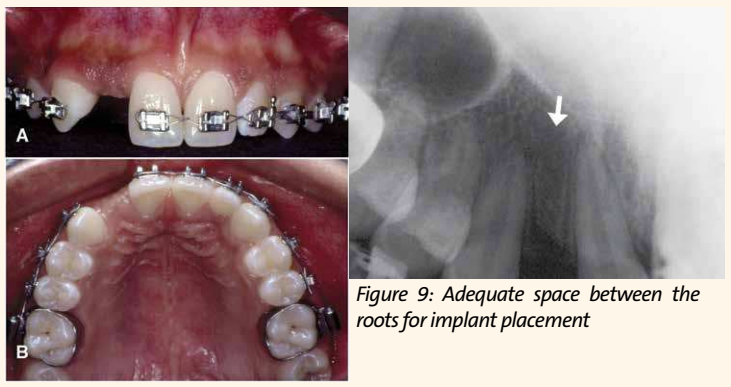

Figure 9: Adequate space between the roots for implant placement

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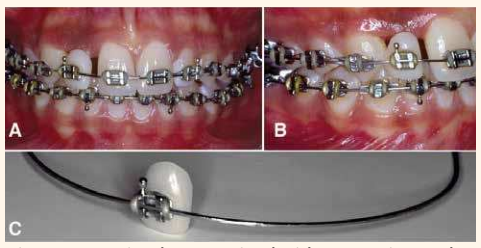

Figure 10: Optimal space gained with appropriate orthodontic mechanics for the restoration, provisional tooth bracketed and attached to the arch wire

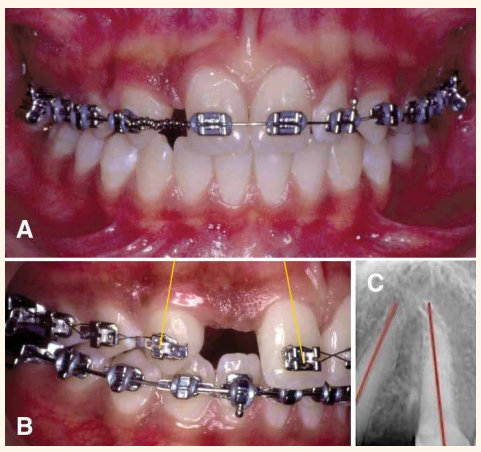

Figure 11: Orthodontic mechanics to open the space (A), adequate intra-coronal space (B), inadequate space between the roots of central incisor and canine as seen radiographically (C).

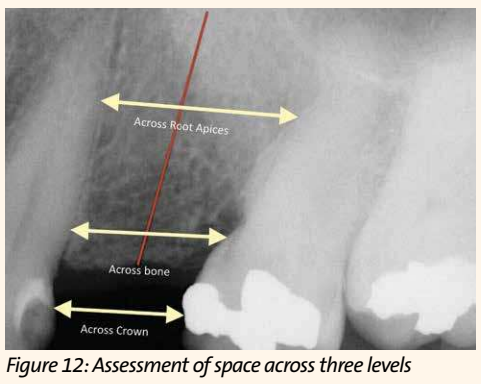

Figure 12: Assessment of space across three levels

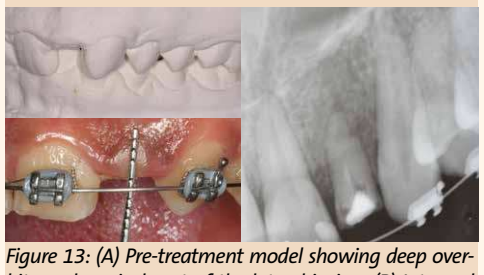

Figure 13: (A) Pre-treatment model showing deep overbite and cervical part of the lateral incisor. (B) Intraoral periapical radiograph shows the presence of maxillary left lateral incisor root piece with good interproximal bone levels. (C) Pocket depth of 6mm in the lateral incisor region indicating facial bone loss.

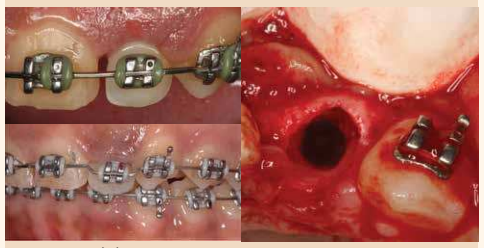

Figure 14: (A) Orthodontic treatment to gain adequate space for implant placement (≠22), implant site development and to improve deep overbite with orthodontic bracket attached to temporary crown on lateral incisor. (B) Controlled vertical eruption of maxillary left lateral incisor root at completion. (C) Lateral incisor root piece extracted, note the presence of adequate bony socket walls.

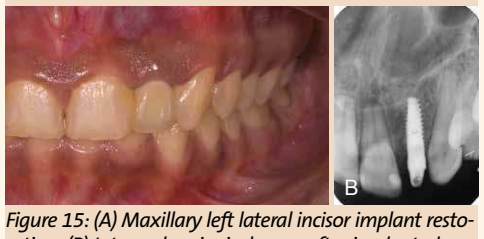

Figure 15: (A) Maxillary left lateral incisor implant restoration. (B) Intraoral periapical x-ray after implant placement, and after abutment loading

Figure 16: (A) Pre-treatment intro-oral photographs showing malformed maxillary lateral incisors and interproximal spacing.

Figure 16: (B) Pre-treatment photographs demonstrating impaired smile esthetics and deep overbite

Figure 17: Orthodontic treatment to redistribute interproximal spaces, correct deep bite and retract maxillary incisors

Figure 18: (A) Pre-treatment intra-oral photographs. (B) Post-treatment: integrated orthodontic and restorative treatment to establish normal tooth proportions and smile esthetics

Figure 19: (A) Pre-treatment smile. (B) Improved post-treatment smile

Figure 20: (A) Pre-treatment vertical gingival discrepancy between 11 and 21 caused mainly by supra-eruption of 21. (B) Mid-treatment photograph demonstrating resolution of this discrepancy by differential vertical orthodontic tooth movements

multiple disciplines of dentistry, it is important to address the patient's main concern, whether the patient is seeking treatment for functional or aesthetic improvement or both. Finding a solution to each individual problem leads to the formulation of a definitive treatment plan (5). A well-structured and organized list of problems makes sure that all areas have been evaluated in the diagnostic phase, and also serves as a valuable reference tool during the course of treatment. All specialists involved in formulating the treatment plan for the patients should provide possible solutions to individual problems based on their own areas of expertise, and no problem should be treated as less important. Provisional treatment plans are then compared with respect to their overall effects, and the plan that enhances the treatment and provides maximum benefit to the patient, considering the patient's chief complaint, is then regarded as final and definitive treatment plan.

The treatment planning process almost always follows the same events; however, the treatment sequence varies significantly from patient to patient due to large variations in morphological configurations and treatment priority. Here, it is critical to organize the sequence of various treatment procedures in such a way that each treatment procedure performed by one of the specialists from the interdisciplinary team facilitates the next in order (Fig.3). Figure 4 illustrates 11-point treatment protocol for interdisciplinary cases.

3) Recognize 'minor dental arch crowding' as a 'major' periodontal concern

Dental arch crowding presents narrow interproximal spaces, which may result in a constriction of the interproximal bone due to reduced interradicular distance (Fig. 5). This compromised bone as a result of septal constriction can be a challenge for both periodontists and prosthodontists. Decrowding of the dentition by orthodontic tooth alignment widens the interproximal bone, which can significantly enhance local host resistance and improve the prognosis of compromised or infected teeth (Fig. 6).

Other than the aesthetic reasons, the resolution of interproximal tissue constriction and faulty contact points and embrasures is the predominant periodontal reason to eliminate dental arch crowding (6).

This integrated orthodontic and periodontic approach as an alveolar development exercise, should be considered as the most compelling periodontal rationale for orthodontic therapy. Hence, it is important to recognize orthodontics to be much more than simply an esthetic domain.

4) Use orthodontic treatment in correction of 'Biologic width' violations

Restorative therapies essentially require a healthy and stable periodontium for long-term success. A dentogingival unit exhibits a constant interplay of gingival tissues with crown contours, restorative material, its texture and its margins. Biologic width is defined as the dimension of space that the healthy gingival tissue occupies coronal to the alveolar bone (7).

It is further elaborated as a total of supracrestal fibers, junctional epithelium and sulcus (8). This concept of existence of a specific width was first published by Gargiulo et al. in 1961 through cadaveric experiments which reveled a mean measurement of a total of epithelial attachment plus connective tissue attachment to be 2.04mm (Fig. 7) (9).

D. Walter Cohen was credited to first coin the term "Biologic width". The significance of this width lies in the fact that it prevents penetration of microbes into periodontium. In 1977, Ingber recommended a distance of 3mm minimum to be kept between restorative margin and alveolar crest for adequate gingival health maintenance (10). This 3mm consists of 1mm of supraalveolar connective tissue, 1mm of junctional epithelium and 1mm of sulcular depth. Violation of this natural seal disrupts dentogingival apparatus making it susceptible to ingress of oral microorganisms and consequently causing gingival disturbances such as inflammation, recession and alveolar bone loss (11 and 12).

Thus it is imperative to minimize irritation to this zone. This measure of 3mm allows for optimum conservation of the mean value of 2.04mm and provides clinical comfort even when the margins are placed 0.5mm within the sulcus.

5) Improve implant site with orthodontics

There are several orthodontic procedures employed to improve implant site for predictable restorations.

Determine the timing of implant placement

Facial growth is the determinant of the age for implant placement in adolescent patients. The osseointegrated implant's lack of eruptive potential makes it to behave like an ankylosed tooth, often causing a discrepancy in the occlusal plane due to continuous eruption of the adjacent teeth. Therefore, early implant placement poses a greater risk of compromised esthetics in the long term. Several studies on young adults who were treated with implant-supported restorations to replace missing teeth have observed discrepancy between implants and adjacent teeth. In a study that followed the vertical changes of maxillary incisors adjacent to implants in a group of adolescents between 15 -20 years of age and adults between 40-55 years demonstrated infraocclusion of the implant–supported restorations, with a vertical step of 0.1 -1.65 mm and 0.12 – 1.86 mm in adolescents and adults respectively (13).

Therefore, lack of proper occlusion and unesthetic situations in the anterior region may be common observations due to jaw growth in patients with implant – supported restorations even if the implants are successfully integrated. The best method to determine the status of facial growth is to superimpose sequential lateral cephalometric radiographs taken at an interval of six months (Fig 8). Generally, the implant should be placed after completion of facial growth (around 17 years in females and 21 years in males.)

Establish optimal implant space

Adequate space gained for the restoration of the normal width of missing lateral incisor based on esthetics and occlusion will determine the appropriate size of the implant to be placed. When selecting the size of the implant, it is important to have 1.5 to 2.0mm space between the coronal diameter of the implant and the adjacent teeth for the development and maintenance of the papillae (14). After the evaluation of coronal space, it is important to radiographically evaluate the interradicular space. The roots of the adjacent teeth should be parallel to slightly divergent with adequate space between the roots for implant placement (Fig.9 A and B).

Once the optimal space has been gained with appropriate treatment mechanics, acrylic tooth of proper size and color shade can be bracketed and attached to the archwire for esthetic purpose (Fig.10). If the space gained for the lateral incisor is in excess, the bracketed acrylic tooth can be used as a template, which will help determining the residual space closure. Clinical evaluation of the edentulous space and radiographic evaluation of the root position of the adjacent teeth should precede appliance removal.

The final implant restoration is significantly influenced by the position and angulation of implant placement. For proper placement of an implant, the minimum space between the adjacent teeth roots is usually 5mm; providing enough room for small diameter implant placement, leaving about 0.75mm of space for the bone between the implant and the adjacent roots (15).

Position adjacent teeth to facilitate restorative treatment

It is a common observation that when an orthodontist is opening up the space for missing lateral incisor; as the force is applied on the crowns of the central and canine teeth, the roots get tipped into the lateral incisor region. This leads to an adequate crown space but the space between the adjacent roots gets reduced, making it impossible for the surgeon to place an implant (Fig.11).

It is equally important to take suffi-

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cient care to make sure that there is adequate interocclusal space for the implant restoration. It is, therefore, critical to establish optimal intracoronal and interradicular spaces; evaluated clinically and radiographically (Fig.12) respectively, for proper implant placement and long-term predictable restoration.

It is best to place an implant during the finishing stage of orthodontic treatment which allows finer manipulation of space, maintenance of space and sufficient time for osseointegration by the time appliances are removed. However, if the implant placement procedure is planned after the removal of orthodontic appliances, the gained space should be maintained during the retention phase.

Consider biologic augmentation

One of the prerequisites for placing an implant and subsequent good soft-tissue integration for more esthetic implant restoration is to have an excellent alveolar ridge. It is a common clinical observation that unrestored edentulous areas typically exhibit compromised bone levels due to alveolar bone atrophy. Research studies have shown that if maxillary anterior teeth are extracted, the alveolar ridge will narrow 34% over period of 5 years (16).

However, these findings related to the alveolar resorptive change do not hold true in cases where the edentulous span has been created by orthodontic tooth movement. Another study which evaluated the long-term width of the alveolar ridge after the required space was created for missing maxillary lateral incisors in adolescent orthodontic patients revealed that the amount of bone loss as result of resorptive changes was less than 1% over a period of 4 years (17).

Orthodontic implant site development is a process involving the root movement that creates adequate alveolar ridge width through stretching of the periodontal ligament fibers prior to the implant placement. This can be accomplished in any part of the alveolar ridge. In addition to the compromised alveolar ridge width, vertical bony defect at the site of implant placement can be influenced by controlled vertical root movement to generate osteoblastic activity before implant placement (Fig.13 - 15). The goal is to create an ideal implant site by establishing adequate alveolar ridge width and height for a predictable and more esthetic implant restoration.

6) Optimize pre-restorative orthodontics

Often management of adult patients necessitates modification from usual treatment approach due to anatomical disfigurements displayed commonly in their dentition caused by previous pathological episodes. Interdisciplinary treatment required for the holistic rehabilitation of these individuals may involve management with periodontal, endodontic, restorative, orthodontic, surgical, etc., specialties. Orthodontic therapy may play a vital role in repositioning of teeth for subsequently planned restorative procedures. Such movements may either include elaborate alteration of teeth positions to reorient occlusal forces, coordination of upper and lower arch forms, appropriate distribution of interdental spaces or simplified movements as guided by localized restorative requirements such as to improve crown-root ratio, achievement of parallelism of abutment teeth, etc.

Size of the teeth play an important role in anterior dental esthetics, and the clinicians are often faced with disproportionate widths of anterior teeth in a day-to-day clinical practice.

This tooth size discrepancy is commonly found in patients with peg-shaped lateral incisors. In such situations, in spite of getting the teeth perfectly aligned and the occlusal discrepancies completely resolved with orthodontic treatment, the abnormal shape and smaller size of lateral incisor pose esthetic problems. This requires planned tooth movements for proper space distribution with orthodontics to restore the normal width of lateral incisor. If a lateral incisor is of normal shape but only slightly narrower than normal, and the discrepancy is bilateral, it may not require any intervention. However, in case of tooth size discrepancy that is unilateral or quite significant, it is imperative to restore the size of the malformed lateral incisors after the completion of orthodontic treatment for overall good treatment result (Fig.16-19).

Pre-restorative orthodontic movements are primarily determined by the type of restoration planned for execution. The main objective of tooth repositioning is to assist in accomplishment of predictable restorations. A classical case constitutes a mutilated dentition (often with parafunctional dental lesions such as attrition or abfraction) usually along with presence of old restorations which may frequently be functionally and/or esthetically compromised possibly resulting in partial or complete collapse of maxillary and mandibular arches in vertical, saggital and/or transverse planes. Presence of either upright or retroclined anterior teeth cause improper anterior guidance without definitive vertical stop, which gradually lead to supra-eruption and subsequent creation of deep bite. Pathological migration disrupts interproximal contacts leading to possibility of production of multiple interdental caries. Consequently, in absence of timely dental intervention, deterioration of the dentition advances significantly. Adjacent teeth drift into carious spaces to seal off the broken continuity and decrease the arch width, produce saggital discrepancy and loss of vertical dimension. Such teeth typically present with tipped roots, which are not parallel to each other and have non-uniform interradicular spaces. Rehabilitation of such a dental architecture involves intense interdisciplinary planning with the restorative dentist. Treatment thus planned should involve strategic sequencing of procedures adhering to the holistic final result objectives ensuring predictability at every stage. Establishment of appropriate inter-incisal relationship with suitable anterior guidance, parallelism of roots and evenly spaced inter-radicular architecture along with well-coordinated upper and lower arches, forms the foremost objective of pre-restorative orthodontic treatment. This creates a reliable foundation for predictable distribution of occlusal forces. Restorations can thereafter be fabricated for long-term functional and esthetic stability. Fine- tuning of tooth positions during the finishing stage of orthodontic treatment can be completed with valuable inputs from the restorative dentist in accordance with the proposed restoration. Likewise, removal of orthodontic appliances can be timed along with restorative interventions so as to ensure avoidance of any untoward tooth movements. Proficient synchronization between orthodontic and restorative strategies is the fundamental aspect for interdisciplinary treatment success.

7) Use customized orthodontic tooth movements to maximize aesthetics

Contrary to traditional orthodontics that is focused solely on improvement of static and dynamic occlusal relationships, contemporary orthodontics encompasses treatment modalities which aim at achieving good occlusal results in-conjunction with enhancement of the entire dentogingival apparatus including prime emphasis on its aesthetic outcome.

In a cosmetically concerned society, aesthetics forms an integral part of patient expectations. This directly mandates orthodontic professionals to systemically explore various factors that promote optimal aesthetics. Adhering to principles of structural balance and functional efficiency, treatment planning should diligently incorporate distinctly defined and customized aesthetic objectives. Various procedures from other disciplines of dentistry can be amalgamated with orthodontic treatment to refine aesthetic potential.

White and pink harmony

Well-finished orthodontic realignment of teeth constitutes perfection of white esthetics within a smile. However, an ideal esthetic smile demands a harmonious balance of both, white and pink components. Color, contour and health of gingival architecture constitute the pink components, which provide the background framework within a smile. Completed orthodontic treatment with appropriately repositioned teeth but neglected gingival discrepancies such as loss of papilla or asymmetrical gingival pattern causes white-pink disharmony leading to an unaesthetic smile (18). Two significant factors related to gingival architecture which need to be considered are:

1. Gingival levels
2. Gingival marginal contour or gingival zenith

Amount of gingival levels seen depend upon the upper lip line in an active smile. In certain individuals, the upper lip does not display any gingiva on smiling while in certain individuals gingival display is evident. For optimum biological health, functional perfection of treatment is inevitable while gingival refinements subjectively elected are purely cosmetic procedures, which may not augment towards health. Thus cases with no gingival display in active smile do not require corrective treatment. Alternatively, cases with noticeable gingival display require corrective measures for achieving white and pink balance within the smile.

According to ideal esthetic parameters, the free gingival margins of the maxillary central incisors and canines are at the same level and those of the lateral incisors are placed slightly coronal. These margins should have contours, which resemble the cement-enamel junctions. Gingival zenith is termed as the most apical point of the labial gingival contour. For the maxillary central incisor and canine it is located just distal to the long axis of the tooth and for the lateral incisor its location coincideswith long axis of the tooth (19). Papillary tip of the gingiva should extend halfway between the incisal edge and the labial gingival height of contour over the center of each anterior tooth. Thus the height of contour of the gingival levels should be centered on the lateral incisors and placed in the distal one-third for the central incisors and canines. Such arrangement of gingiva provides a semicircular appearance for the lateral incisors and an elliptical appearance for the canines and central incisors. Periodontal assembly is carried along with the erupting tooth. Presence of asymmetric tooth eruption will alter the underlying crestal bone levels, which provide support to the overlying gingival pattern. Therefore asymmetries in gingival levels will result. Orthodontically, these clinical situations can be modified by intrusion or extrusion of teeth (Fig. 20).

Conclusion

An interdisciplinary orthodontic treatment presents the philosophy and treatment strategy that also involves a group of professionals from other disciplines of dentistry as a cohesive team. This approach to manage complex clinical situations is highly sophisticated treatment modality and requires excellent communication and coordination among the team members. The goal is to simplify and idealize the treatment plan by providing solutions to a variety of clinical situations, which improves overall treatment prognosis and enhances treatment results.

Initially, this approach may seem to be out of reach of most practitioners, however when implemented regularly, this collaborative approach results in very efficient protocols and execution that patients appreciate and benefit from.

The author has, since the initial days of orthodontic practice, enjoyed the professional collaboration with specialists from other disciplines of dentistry in a fruitful career and continues to maintain professional enthusiasm with them.

This unique approach to manage complex clinical problems will certainly inspire readers to engage in their own interdisciplinary collaboration, and advance the practice of dentistry for the benefit of the patient and community at large.

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