

TRANSFER OF INFORMATION FOR ESTHETIC AND FUNCTIONAL PREDICTABILITY IN SEVERE WEAR CASES



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Prosthodontists are often called upon to reconstruct the occlusion in patients with severe wear. There may be a multitude of issues to address in such cases, including attrition, abrasion, and erosion, all of which contribute to uneven wear and compensatory eruption throughout the arches. There may also be incisal wear and/or interproximal wear, and as a result, the occlusal plane may need leveling and lengthening for enhanced esthetics and to allow correction and control of the occlusal relationship.

Treating the edentulous patient requires the fabrication of occlusion rims to allow evaluation of critical esthetic and functional information, mounting of the final casts, and fabrication of esthetic and functional complete dentures.¹⁻⁸ The esthetic and functional information includes determination

of the incisal edge position at rest, the occlusal plane, midline and angulation of the midline, lip support, facial plane of the incisors, arch form, and buccal corridors. In addition, the clinician can evaluate the vertical dimension of occlusion, check phonetics, and take a centric record.

CRITICAL ESTHETIC DETERMINANTS

All comprehensive treatment planning should begin with an esthetic evaluation. Evaluation of the face is essential in determining the ideal esthetic orientation of the teeth from a horizontal perspective. The horizontal reference planes will help the clinician align the occlusal plane and the soft tissue levels along with other related esthetic determinants. The horizontal reference planes should be evaluated from two perspectives: the frontal and the sagittal. The frontal perspective is assessed by having the patient look out into the horizon and choosing the ideally leveled plane. The most commonly used horizontal reference

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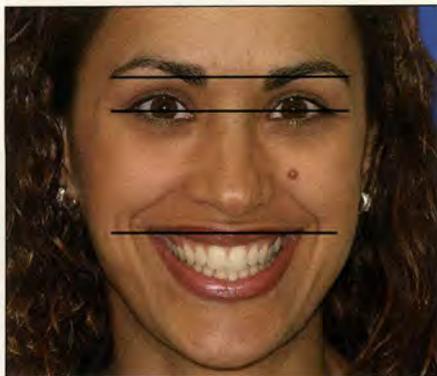


Fig 1 Horizontal reference planes: ophriac, interpupillary, and commissural planes respectively.



Fig 2 Sample incisal edge at rest.



Fig 3 Sample incisal plane.



Fig 4 Sample occlusal plane.

planes include the ophriac line, interpupillary line, and commissural line (Fig 1).^{5,9-10} Most people are slightly asymmetric in these planes, and in these cases, the floor is used as the horizontal reference plane. From a lateral (sagittal) perspective, the patient holds his or her head erect, again looking out to the horizon. From the sagittal perspective, the horizontal reference plane should again be leveled with the floor. Once the horizontal reference plane is established, the critical esthetic determinants are established in relationship to the horizontal reference plane.

The incisal edge position, incisal plane, and occlusal plane are the three most important esthetic determinants in the development of the treatment plan. These determinants enable the clinician to transfer information throughout the treatment, and are related in specific ways to other esthetic criteria. The first step in determining the position of the teeth is evaluation of the incisal edge position at rest (Fig 2). Tooth exposure is considered to be esthetic in the 1- to 5-mm range.^{8,11} To

achieve this range, tooth proportions can be adjusted by either shortening or lengthening the anterior teeth. For example, if crown lengthening is indicated on teeth that were previously ideally proportioned, the incisal edge length can be reduced. Maintaining a minimum of 1 mm of tooth exposure at rest should be the goal. Once the final incisal edge position is determined, the incisal plane (a line from canine to canine in the anterior portion of the occlusal plane) is evaluated (Fig 3). The incisal plane should be leveled to the chosen horizontal reference plane (the floor, interpupillary line, etc), and evaluated from the frontal perspective while the patient is smiling. The next step is to evaluate the occlusal plane from a sagittal view of the patient's smile. The occlusal plane should be flat from the incisal edge of the central incisor back to approximately the mesial of the first molar (Fig 4). The illusion of a radial relationship of the smile line to the lower lip derives from the cant of the maxilla in the frontal perspective (see Fig 3).



Fig 5 Casts mounted using the occlusal plane guide.



Fig 6 Mounting plate mounted against the occlusal plane guide.



Fig 7 Evaluation of the incisal edge at rest with the occlusal plane guide.



Fig 8 Evaluation of the occlusal plane using the occlusal plane guide with the patient smiling.

The original occlusal plane guide technique

As with the edentulous patient, a method of transferring critical esthetic and functional information is needed to allow the technician to predictably achieve the ideal esthetic orientation and occlusal relationship of the teeth in the waxup. The original occlusal plane guide technique¹² employed a vacuform machine and acrylic resin to evaluate the ideal esthetic determinants in the patient's mouth. The maxillary cast was mounted to the articulator with the occlusal plane guide using a facebow, an earbow, or a dentofacial analyzer. The mandibular cast was mounted at the evaluated vertical dimension using the occlusal plane guide (Fig 5). The mandibular cast was removed, and a flat mounting plate was placed against the acrylic resin and mounted to the lower member of the articulator (Fig 6). When the occlusal plane guide was removed, the space between the original cast and the flat plane indicated the exact amount the teeth needed to be lengthened. Unfortunately, there were problems with delamination of the acrylic

resin from the vacuform material, and the acrylic resin was difficult to trim and shape. Wax is a more suitable material for this technique due to its ease of trimming and shaping, and its ability to take a centric record at the appropriate vertical dimension (Figs 7 and 8). The centric record should be taken at the appropriate vertical dimension with both the ideal overjet and overbite relationship. This will minimize the negative effect of the arc of closure if the casts are not mounted in a direct relationship to the hinge axis of the articulator and the vertical dimension is modified.

Diagnostic waxup fabrication

Step 1: Develop the occlusal plane

Mount the casts on the articulator at the correct vertical dimension and relative to the mounting plate, and remove the maxillary wax occlusal plane guide. The resulting space indicates the amount of wax to be added to reach the ideal occlusal plane (Fig 9). First, add wax to the incisal edges of the anterior teeth and the buccal cusp

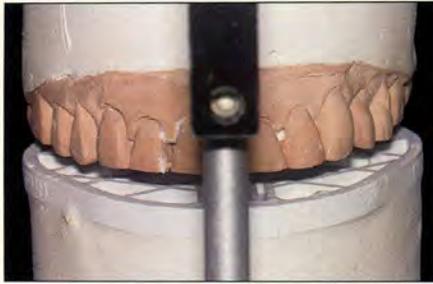


Fig 9 Maxillary cast without the occlusal plane guide.



Fig 10 Wax is added to incisal edges of anterior teeth and buccal cusp tips of posterior teeth.



Fig 11 Evaluation of vertical dimension with the casts together.



Fig 12 Lingual view of waxup creating anterior guidance.

tips of the posterior teeth (Fig 10). If wax is added to fill the space from the mounting plate distal to the mesial cusp of the first molar, it will be impossible to close the casts together in the posterior area due to the axis of closure of the hinge. Therefore, the length of the wax distal to the first molar should be short of the mounting plate, but equal in distance from the flat plane on both sides.

Step 2: Alter the vertical dimension of occlusion (if needed)

Ideally, the casts should be mounted at or close to the correct vertical dimension of occlusion based on the restorative space needed to develop the ideal anterior relationship, including the anterior guidance and room for the envelope of function. If the casts are mounted at the ideal vertical dimension of occlusion, the effect of the arc of rotation will be insignificant. If the casts are not mounted at the ideal vertical dimension, open or close the articulator pin to develop the ideal space needed for the restorative material (Fig 11). If the casts do not close to the ideal position, ei-

ther shorten the maxillary posterior teeth, move the maxillary buccal cusps facially, or move the mandibular buccal cusps lingually. This is a purely subjective process and can be refined during the next step.

Step 3: Develop the anterior guidance

If the mandibular anterior incisal plane is irregular and the treatment plan calls for restoration of the mandibular anterior teeth, level the mandibular incisal plane with wax, followed by the lingual aspect of the maxillary anterior teeth, to develop the correct anterior guidance relationship. If only one arch will be restored, add wax to the appropriate teeth (Fig 12).

Step 4: Level the mandibular posterior plane

If the mandibular occlusal plane requires leveling, add wax to the mandibular occlusal surfaces to level the mandibular arch (Fig 13). It may not be possible to level the mandibular posterior plane with the mandibular anterior plane because this may require opening the vertical dimension too much. If this is the case, level as much as possible.



Fig 13 Evaluation of space to wax the mandibular occlusal surfaces.

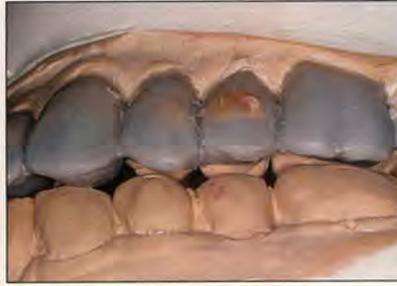


Fig 14 Evaluation of space to wax the maxillary occlusal surfaces.



Fig 15 Final waxup.

The level of the lower posterior plane can be evaluated by opening the pin slightly and assessing the space between the maxillary and mandibular posterior cusp tips. There should be equal space on either side of the arch.

Step 5: Add wax to the maxillary occlusal surfaces to develop the occlusal contacts

Once the mandibular teeth are ideal, add wax to the maxillary posterior occlusal surfaces to fit into the mandibular occlusal surfaces in the correct relationship (Fig 14).

Step 6: Refine the occlusion and perfect the contours

Add to or modify the occlusal surfaces to perfect the occlusal relationship and to idealize the esthetic contours (Fig 15). The final contours of the central incisors should be determined first, followed by the lateral incisors and canines, since the symmetry of these teeth is not as critical as the central incisors.

Relationships to the critical esthetic determinants

There are certain relationships that can be developed regarding the critical esthetic determinants. It has been established that the midline position is not as critical as the midline verticality.¹³ If the incisal plane has been idealized in the waxup, the midline should be perfectly *perpendicular* to the incisal plane. Ideally, the facial plane of the in-

cisors should be *perpendicular* or slightly acute relative to the occlusal plane from a sagittal perspective. The gingival plane should be *parallel* to the incisal plane.

CASE PRESENTATION

An 82-year-old man presented to the office in need of a complex rehabilitation. He had noticed rapid wear on his anterior mandibular teeth in the last couple of years, and that his maxillary and mandibular anterior teeth were "on top of each other." Considering the severe occlusal wear and Class III malocclusion, a thorough esthetic evaluation was done to formulate a treatment plan. The incisal edge position at rest was evaluated first. The patient showed approximately 2 to 3 mm of tooth structure with the lips in repose (Fig 16). According to esthetic principles, this fell within the desired range. When the patient smiled, the incisal plane also seemed adequate; however, a distinct step between the anterior and posterior planes existed, indicating an esthetic need to lengthen the maxillary posterior teeth (Fig 17). Opening the vertical dimension of occlusion would be beneficial in this case because this patient was in need of a dramatic leveling of the maxillary occlusal plane and the mandibular incisal and occlusal planes to create room for development of a better functional relationship of the anterior teeth (Figs 18 to 20).

CASE PRESENTATION



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Fig 16 Initial incisal edge at rest. Note the good position of incisal edges and incisal plane.

Fig 17 Initial smile. Note the discrepancy in the posterior occlusal plane.



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Fig 18 Initial right lateral view. Note the discrepancy between the anterior and posterior occlusal planes.

Fig 19 Initial intraoral view. Note the discrepancy of the mandibular anterior incisal plane.

Fig 20 Initial left lateral view. Note the discrepancy between the anterior and posterior occlusal planes.

Modified occlusal plane guide technique

In this case, the anterior occlusal plane was deemed adequate at the esthetic evaluation, so the wax was added to the posterior occlusal plane. This occlusal plane guide was tried in the mouth and shaped to the correct length corresponding to the ideal esthetic plane. A centric record was taken at the anticipated vertical dimension to aid in creating a better relationship in the anterior region, as well as room to level both the maxillary and mandibular occlusal planes.

Mounting the casts

Once the wax of the occlusal plane guide was idealized, the maxillary cast with the occlusal plane guide was mounted on the Kois dentofacial analyzer mounting plate (Panadent, Grand Terrace,

CA, USA) by aligning the facial aspect of the incisors with the line drawn on the platform (Fig 21). The midline on the maxillary diagnostic cast was aligned with the midline drawn on the platform. The Panadent system mounting platform was developed using scientific data (unpublished research, 2006), so there is no need to use the dentofacial analyzer or an earbow leveled to the horizontal plane with this technique (Figs 22 and 23). The incisal edge position on the mounting platform that was used to align the cast is based on a 100-mm measurement from the hinge axis of the articulator (Fig 24). According to Kois and Kois and others,¹⁴⁻¹⁸ this measurement is the average in the population from the hinge axis to the incisal edge position, with 80% of the population falling within 1 standard deviation of the mean. The maxillary cast was mounted relative to the hinge axis using the mounting plate. By using the wax to mount the cast, there was an ideal esthetic relationship of the cast to the mounting plate. Once



Fig 21 Diagnostic cast mounted on the dentofacial analyzer mounting platform using the occlusal plane guide.

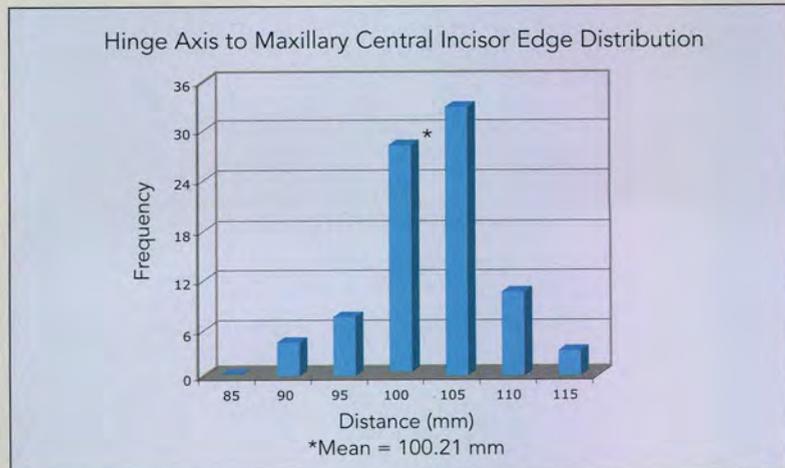
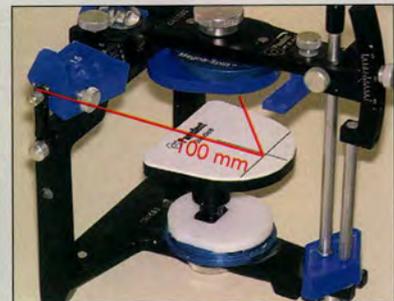


Fig 22 Diagram of findings in research conducted by Kois and Kois.¹⁴

Fig 23 Illustration of measurement in research conducted by Kois and Kois.¹⁴



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Fig 25 Maxillary waxup on the dentofacial analyzer mounting platform.



Fig 26 Final waxup. Note the perpendicular relationship of the incisal plane to the interincisal angle.



Fig 27 Lateral view of final waxup. Note the perpendicular relationship of the facial plane of the incisors to the occlusal plane.

the maxillary cast was mounted, the mounting plate was removed and the mandibular cast was mounted using the occlusal plane guide at the appropriate vertical dimension. The wax occlusal plane guide was removed and the diagnostic waxup was fabricated as previously described, although the maxillary cast was waxed against the

dentofacial analyzer mounting plate rather than a standard mounting plate (Fig 25). Both arches were leveled and aligned to the horizontal reference plane, and other relationships, such as the interincisal angle and the facial plane of the incisors, were also incorporated in the waxup (Figs 26 and 27).



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Fig 28 Frontal view of the provisional prostheses.

Fig 29 Intraoral view of the provisional prostheses.



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Fig 30 Maxillary preparations.

Fig 31 Mandibular preparations.



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Figs 32 and 33 A different case requiring crown lengthening. (*left*) Provisional prostheses prior to crown lengthening. Note the measurements given to the surgeon prior to crown lengthening. (*right*) Provisional prostheses after crown lengthening. Note that the soft tissue level is parallel to incisal plane.

Making the provisional prostheses

Once the waxup was complete, a provisional shell was made by fabricating a matrix and painting in both incisal- and dentin-colored cold-cure acrylic resin. These prostheses were filled with acrylic resin, relined in the mouth, trimmed, and equilibrated slightly. It was difficult to visualize the esthetic aspect of the provisional prostheses while the patient was anesthetized, so he was allowed to leave and return 1 week later for further refinement. There will almost always be a need to slightly recontour the provisional prostheses to achieve the desired esthetic outcome, but modification of the incisal edge position and occlusal plane is rarely needed when this technique is used (Figs 28 and 29).

Crown lengthening

This patient refused crown lengthening, but after preparation there was enough tooth structure for retention of the final restorations (Figs 30 and 31). In a complex wear case, a surgical procedure is often needed to level the soft tissue for esthetic and/or structural reasons. Because the ideal incisal edge position and incisal plane are developed in the provisional stage based on the horizontal reference plane, it is easy to develop ideal soft tissue levels. If the clinician has determined the proper esthetic and structural length for the teeth, he or she can ask the surgeon to measure from the incisal edge up to the desired soft tissue height and add 2.5 to 3.0 mm of length for the biologic width to achieve the new bone level (Fig 32). Once the



Fig 34 Centric record of the maxillary provisional prosthesis to the mandibular preparations.

Fig 35 Centric record of the maxillary preparations to the mandibular provisional prosthesis.

Fig 36 Centric record of the maxillary preparations to the mandibular preparations.

bone level is idealized, the soft tissue is positioned and sutured 2 to 3 mm more coronal than the bone. If the ideal tooth width has been developed in the provisional prosthesis, the surgeon also has the information necessary to scallop the bone so the gingival zenith will be in the correct position (the height of the contour of the soft tissue, distal to the center of the tooth) (Fig 33).

Centric record and cross-mounting

Once the biologic width is redeveloped and the provisional prostheses are relined, a final impression is taken of at least one arch. This is then mounted on the articulator using the dentofacial analyzer to develop the correct relationship with the face. The various centric records allow the technician to mount the casts of the provisional prostheses and the preparations in identical 3-dimensional positions. Four critical relationships (centric records) need to be taken if both arches are to be fabricated at the same time. The first is a provisional prosthesis-to-provisional prosthesis relationship (see Fig 29). There is no need to take an occlusion rim for this relationship if there is an ideally generated occlusal relationship that shows bilateral simultaneous contacts in centric occlusion. The second and third centric records are

those of the preparations against the opposing provisional prostheses in both arches (Figs 34 and 35). The final relationship needed is the centric record of the preparations to preparations (Fig 36).

If only one arch is undergoing restoration, the provisional-to-provisional and provisional-to-preparation relationships need to be taken only for that arch. These 3-dimensional relationships of the preparation casts to the provisional casts are essential in allowing the technician to duplicate both the esthetic and functional relationships that were developed in the provisional prostheses.

Transferring information in the laboratory

Once the casts are mounted and have become interchangeable, the technician must use the information from the provisional prostheses. One such transfer of information is the incisal guide table (Fig 37). This is fabricated by placing acrylic resin (GC America, Alsip, IL, USA) within the table that houses the pin. When the acrylic resin is in the doughy stage, the upper member of the articulator with the provisional cast is moved against the opposing cast in all directions to replicate the guidance. This movement creates a trough through the acrylic resin. After the acrylic resin

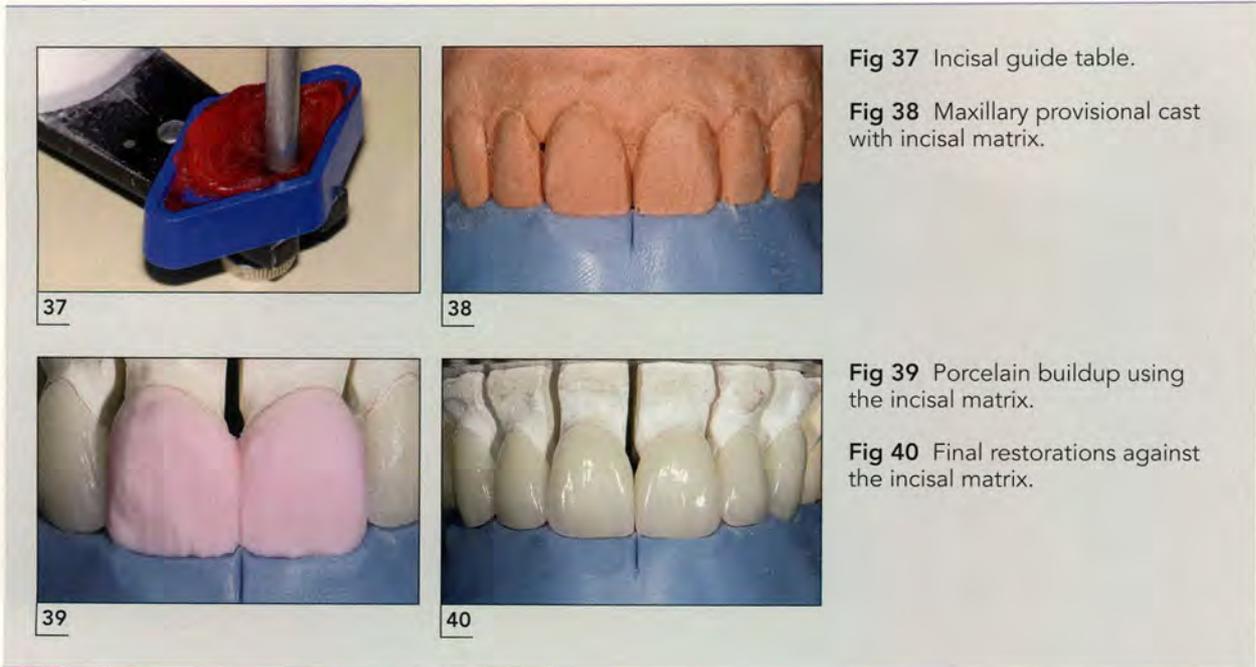


Fig 37 Incisal guide table.

Fig 38 Maxillary provisional cast with incisal matrix.

Fig 39 Porcelain buildup using the incisal matrix.

Fig 40 Final restorations against the incisal matrix.

hardens, the trough will guide the lingual contours of the restorations on the preparation cast to match the provisional cast.

The next transfer of critical information in the laboratory is the fabrication of matrices. The main matrices used in the laboratory are the facial matrix, the lingual matrix, and the incisal matrix. The first two allow verification or reduction of either the waxup or framework, as well as comparison of the final prosthesis to the provisional prosthesis from a facial and lingual contour perspective. This saves time because the technician does not have to remake the waxup. Because the provisional prosthesis is the pattern for the final prosthesis, all the esthetic and functional information is present. The next step is to open the pin by 1 mm and fabricate a matrix against the incisal edges and cusp tips of the maxillary provisional cast (Fig 38). When the provisional cast is replaced with the preparation cast, the laboratory technician knows exactly how much material to add incisally in the frame to support the ceramics and for the final length of the ceramics. This matrix can be used to fabricate the ideal porcelain buildup. If the technician knows how much shrinkage will result, the pin can be opened by that amount, and after the first

bake, the incisal edge will be nearly in the perfect position (Figs 39 and 40). The final prostheses should fit intimately to the incisal matrix.

CONCLUSION

It is evident that the transfer of information throughout the rehabilitation process is critical. Although it may take a bit more time in the diagnostic phase of treatment, accurate means of transferring information throughout the rehabilitation process is paramount to predictability. In severe wear cases where the teeth are too short and need to be lengthened, the incisal plane guide is an indispensable tool. By transferring the critical esthetic determinants to the articulator, the process of waxing becomes easier and more predictable. If the patient needs crown lengthening, all the information necessary for esthetic success is already incorporated in the provisional prosthesis because the critical esthetic determinants were used for fabrication. Once the provisional prosthesis is idealized and the correct occlusal relationships are taken to allow cross-mounting the casts, fabrica-



tion of the incisal guide table and matrices from these casts will guide the laboratory technician to ensure esthetic and functional predictability in the final restorations (Figs 41 to 43).

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ZIRCONIUM OXIDE CAD/CAM-GENERATED RESTORATIONS: AN ESSENTIAL OPTION IN CONTEMPORARY RESTORATIVE DENTISTRY

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Two of the most important characteristics of modern restorative dentistry are:

1. The ability to integrate an interdisciplinary treatment plan
2. A full understanding of current restorative materials and technology

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The treatment planning phase unquestionably represents the foundation of contemporary dentistry.¹ Whether dealing with the restoration of a single tooth, an implant, or a full-mouth reconstruction, it is through this planning phase that the dental team must set the road map for therapy. While the final outcome may be reached through a variety of pathways, close communication between specialists is essential to choose the ultimate route of treatment.

Indeed, there is no better investment than the time spent during treatment planning. The interdisciplinary team should not overlook even the slightest detail regarding the treatment options.

The starting point for any therapy should be a full understanding of the patient's needs, desires, and complaints. Clinicians should explore the patient's mind before diagnosing his or her mouth, and devote as much time as necessary during