**Dental Anatomical Combinations – A Guide to Ultimate Dental Esthetics**

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**ABSTRACT**

This article is aimed to codify these steps so as to simplify and clarify the procedures, using a new and simple system that will enable the dental professional to go beyond the usual uninteresting creative standards in esthetic rehabilitation. In the list part the principal tooth forms, their characteristics, and the relationship between surfaces will be analyzed. This will create the base for the introduction of a new tooth form classification guide, called Dental Anatomical Combinations. By sectioning the three principal forms of teeth and recombinining their individual characteristics new tooth forms can be created. Then, the numerous possibilities for anatomical tooth reproduction, in order to achieve the most suitable form for each particular case, are highlighted. Application of the new system will be demonstrated in a clinical case.

**KEYWORDS**

Dental Anatomy, Individual Shape, Transition Lines, Dental Anatomical Combination (DAC).

**INTRODUCTION**

To create an aesthetic dental rehabilitation is undoubtedly a complex operation. Numerous factors need to be studied and evaluated when modeling a restoration, including tooth alignment, dimensions of the clinical crown and occlusion. A correct understanding of all these anatomical parameters is essential to create an esthetic restoration that is as harmonious as possible. For the construction of a tooth we need numerous requirements that may make the composition somewhat difficult, but at the same time we feel that some complexity is necessary to enrich the beauty of the result.

**THE THREE BASIC FORMS OF TOOTH ANATOMY**

Different facial and dental forms exist in nature, and some scholars of the past have proposed these types as the starting-point on which to base the rehabilitation of patients requiring an fixed or removable restoration. Various concepts have been introduced describing correlations between dental form and other factors, such as gender, constitutional type, or personality. Even though these concepts have been disproven, today some professionals still consider these theories applicable to anterior restorations. However, we doubt whether application of this mathematical rules can provide a predictable outcome, since it tends to annul the creative approach and penalize the result of the final rehabilitation.

The literature tells us that there are three basic tooth forms in nature: the Square form (type A), the Ovoid form (type B) and the Triangular form (type C).

**Square:** The mesial and distal proximal surfaces are parallel and perpendicular to the incisal edge and present a cervical area that is a wide U-shape. The vestibulo-distal transitional ridge may be slightly curved, the incisal edge is straight or slightly curved. The incisal edge is longer in the mesio-distal direction than in the cervical direction. (Fig. 1)

**Ovoid:** The incisal edge has a central protuberance; its length in the mesio-distal sense is the shortest of the basic anatomic forms. The mesial and distal transition line angles are rounded and converge at the incisal and cervical. The U-shaped cervical line is more oval than in the square type. (Fig. 2)

**Triangular:** The distal ridge is not parallel to the mesial ridge, but markedly inclined defining a very narrow V-shaped cervical zone with a convexity at the center of the crown. The incisal edge is wide in the mesio-distal sense and may have a slight curve at the center or a mere convexity. The incisal angles are slightly acute. (Fig. 3)

**OUTLINE AND FORM**

During the design stage all forms must be evaluated from an incisal, a cervical, and frontal view with a right-lateral and left-lateral projection, grasping the overall organization of the tooth and the relationship between the anatomic parts. (Figs. 5, 6, 7)

The three principal types of tooth form include numerous variations and these do not only involve the shape but also the form of the teeth. In this context the word “form” indicates all the macro-characteristics such as the outline of the tooth, development of the ridge, depth of grooves, difference between mesial and distal incisal angles (Fig. 4). Another element that is closely linked to the anatomical qualities of the tooth is the surface texture or micro-characteristics. (Fig. 4)

The physical form of an object is determined by its outline, comprising the incisal border, proximal ridges and cervical line. These lines dictate the path of the valleys and the shape of the lobes; these interconnected characteristics determine the volume and at the same time the form we are interested in creating. Thus the tooth should not immediately be studied in three dimensions; rather we should first consider the outline.

**TRANSITION AREAS AND LINES**

Characteristics of form are not separate entities but rather combine to form a single feature: this means that the tooth is crossed by grooves, connected logically, that determine three-dimensional anatomical areas. Natural teeth are not the result of a random cut; during their formation they produce components such as ridges and cusps, the grooves and fossae are the result of this formation. The frontal view does not provide sufficient information to reproduce the area present around a transition line. A transition line must be formed considering the three-dimensional correlations, and to achieve this we must begin to work on each transition line starting from the lingual surface. In all natural teeth, the ridges and grooves, starting from the lingual surface, are connected to the proximal and vestibular surfaces (Fig. 7).
TORSION
There is another principle that relates to natural teeth: surface torsion. If we view the teeth from the incisal viewpoint, the distal protrusion becomes evident at the level of the cervix. Failure to understand this torsion may result in artificial incisors that appear flat or distally protruded. The line of rotation starts from the vestibular face and continues in the lingual direction creating movement that can clearly be seen in the incisal view (Fig. 8).

In the incisors torsion is gentler, in the canines it is more pronounced; however, the technician may define the extent of torsion depending on the form that is wished to impart to the esthetic rehabilitation. In more facially positioned teeth, this characteristic is more evident; however, torsion is common to all teeth to a greater or lesser extent, although the extent of rotation varies from one tooth to another.

DENTAL ANATOMICAL COMBINATIONS
Based on the anatomical knowledge and three basic tooth forms, we can now introduce a new tooth form classification system, called “Dental Anatomical Combinations”. This new and simple concept aims to help in the codification of a system that will enable the dental professional to produce different tooth anatomies that go beyond the standard tooth shapes.

The basic principle of this system is based on segmentation and recombination of two or even three principal tooth forms. First, the perimeter of each tooth form is sectioned into smaller segments. E.g., by sectioning the tooth into three different segments a mesial, distal, and incisal segment can be obtained (Fig. 9). If necessary these segments can be further divided in half, resulting in six half segments: mesial cervical, mesial body, mesial incisal, distal cervical, distal body, and distal incisal (Fig. 9). To create the final form these full or half segments can be recombined, forming so called “Complementary Classes” (Table 1). The class numbering (1:3, 1:2, ½:3, or ½:2) indicates which segment was used (number before the colon: either full (1) or half (1/2) segment) and with how many basic tooth forms it was used for recombination (number after the colon: either 2 or 3 basic tooth shapes).

The first complementary class 1:3 uses one full segment of each of the three principal tooth forms, resulting in 6 different tooth shape combinations (Fig. 10 a,b).

The second complementary class 1:2 uses one full segment, combining it with only two different principal tooth forms. This results in 18 different tooth shapes (Figs. 11-13).

The third and fourth complementary classes ½:3 and ½:2 involve only half segments, which were combined with 3 or 2 different segment combinations. Only six combinations shown, even though more are possible (Fig. 14 a,b). The first combination 1:3 (Fig. 10 a,b) and second combination 1:2 (Fig. 11 a,b) involve all three basic tooth forms. In the third combination ½:3 (Fig. 12 a,b) and fourth combination ½:2 (Fig. 13 a,b) only two basic tooth forms are used. The third and fourth combinations are further divided into two sub-combinations, one using the ovoid and the other using the triangular tooth form. The third combination ½:2 (Fig. 14 a,b) uses the ovoid and triangular tooth forms, while the fourth combination ½:2 (Fig. 15 a,b) uses the square and triangular tooth forms.

The fifth combination ½:3 (Fig. 16 a,b) uses the ovoid, triangular, and square tooth forms, while the sixth combination ½:2 (Fig. 17 a,b) uses the square and triangular tooth forms. The former combination involves only one basic tooth form, while the latter combination involves two basic tooth forms. The fifth and sixth combinations are further divided into two sub-combinations, one using the square and the other using the triangular tooth form. The fifth combination ½:3 (Fig. 16 a,b) uses the square and triangular tooth forms, while the sixth combination ½:2 (Fig. 17 a,b) uses the square and triangular tooth forms.

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Esthetics

principal tooth shapes. By dividing the tooth vertically or obliquely into two parts of the three tooth the segments are always in contrast in the final shape, giving it a more dynamic appearance. Even though for both classes mathematically many more combinations are possible, only a selection of them is shown.

In total we have presented 48 anatomical tooth combinations, giving us more possibilities to create teeth than those offered by the usual three shapes. These new combinations enable us to understand how the tooth can have contrasts that give the tooth a more dynamic appearance. The combination of these contrasts, both in form and in the composition of the hue, can help us to range more widely and with greater creativity in order to achieve an esthetic rehabilitation. Segmentation is a means of composition that is particularly necessary and evident to facilitate practical orientation. In the laboratory needs, it is a visual message, thus a concrete rather than an abstract concept that allows us to understand and produce the tooth shapes that we desire.

CASE REPORT
A 46-year-old male patient presented with concerns about the esthetics of his maxillary anterior dentition. His chief complaint was the diastema between both central incisors and between the right central and canine (Fig. 18 a-f). Both of his maxillary lateral incisors had been congenitally missing and were substituted by moving his canines and premolars orthodontically at a young age. However, spaces between the anterior teeth had not been closed completely at that time and besides minimal enamoplasty, the transformation of the canines to lateral incisors has remained unfinished since then. The patient did not undergo orthodontic treatment again. He wished an esthetic, but minimally invasive treatment under preservation of as much intact tooth structure as possible. The treatment plan comprised six veneers covering the maxillary central incisors, the canines, and the first premolars.

DIAGNOSTIC WAX-UP

Preceding the treatment plan decision, impressions were taken to fabricate diagnostic casts and a diagnostic wax-up (Fig. 19 a-g). The diagnostic cast showed a triangular-avoid tooth configuration of the maxillary incisors. However, to close the diastema and redistribute the interproximal spaces more effectively a 1/2:3 complementary class, combining all three principal tooth shapes, was chosen for the wax-up. Beginning with the marginal ridges, incisal cones and central ridge were then waxed-up in the most suitable position, finishing with the facial surface (Fig. 19 a-c).

During all stages of the process the correct proportions of the anatomical features have to be controlled from all dimensional aspects (Fig. 19 d-g). Once the facial surface completed, we can work on the surface characteristics (Fig. 20 a-c). Figure 21 a-h) is showing the finalized wax-up with the successful transformation of the canines into laterals and the first premolars into canines. Figure (21 f) shows both central incisors with the complementary class ½:3 applied. Both teeth were divided in 6 half segments and the three principle tooth forms were used to recombine the final outcome.

In order to transform the shape of the canines to the shape of lateral incisors, differences in overall shape, size, and anatomical features, such as mesio-distal and oro-facial width, need to be considered. Therefore, a measurement of the cervical area of the two canines was taken to evaluate the differences in these parameters between canines and lateral incisors. The canine had in the cervical area a mesio-distal and an oro-facial width of 7 mm (Fig. 22 a-c), while for a lateral incisor the average mesio-distal width in the cervical and oro-facial dimensions are around 5 mm. To create a
The clinical preparation. which were delivered to the dentist as a guide during use as a useful tool in the communication between the technician and the dental technician. Considering these parameters, a preparation was simulated in the lab (Fig. 24 a-d). Such a simulation is a useful tool in the communication between the technician and the dentist. Based on this preparation simulation and on the wax-up silicon keys were fabricated (Fig. 25), which were delivered to the dentist as a guide during the clinical preparation. Furthermore, this preparation simulation allowed the fabrication of a shell provisional.

**TOOTH PREPARATION**

For clinical preparation, the silicon guides were used to initially verify the original dimensions of the teeth in relation to the projected shape as outlined in the wax-up (Fig. 26 a). No preparation was necessary on the two central incisors. Preparation on the first premolars remained minimal, including only the facial surface. The occlusal and lingual aspect of the first premolars remained completely untouched. On the canines the preparation was performed as projected in the preparation simulation. Using diamond burs (Komet, Lemgo, Germany) the incisal edge was reduced 1mm, followed by the facial surface with a 1mm reduction and a light chamfer at the cervical margin. The mesial and distal surfaces were each reduced by 1mm using diamond burs, and diamond coated discs (Komet, Lemgo, Germany) (Fig. 26 b,c) were used to retrace and protect the soft tissue (Fig. 26 b). Prior to impression retraction cords without any hemostatic agent were placed (Fig. 26 e). A polyvinylsiloxane impression material (Extrude EXTRA and WASH, Kerr, Orange, CA, USA) was used in double-mix technique to capture the preparations. The prepared teeth were provisionalized with the pre-made shell provisional after relining.

**CERAMIC**

To manufacture the ceramic veneers an alveolar model was fabricated, consisting of an intact soft tissue model and interchangeable dies (Fig. 27 a, b). The presence of the soft tissue is fundamental in the creation of the final rehabilitation, because it is the key in positioning transition lines, and the tissue allows to have more control over the tooth shape.27,28 Felgspathic ceramic (Creation, Jensen, North Haven, CT, USA) was layered to create the veneers. The first step of the laying process was to apply two layers of connector material on the refractory dies in two different firings (Fig. 27 d). After that different enamel and translucent masses were added to build the incisal wall (Fig. 27 e). Modifiers and stains were added in order to obtain incisal effects; the mesial and distal aspects were built in the same manner followed by the first bake. Then the entire labial shape was layered using twenty different ceramic masses (Fig. 27 f).

After the next bake the ceramic was ground with diamond burs (Komet Dental, Lemgo, Germany) to create the desired anatomical shape and texture. Following the glazing, which harmonized the texture in relation with the patient’s adjacent teeth, all veneers were manually polished. At this point the veneers were ready to be removed from the refractory dies by sandblasting with glass beads at low pressure. They were adapted on the master dies under a stereo-microscope at x12 and x20.
TRY-ON AND CEMENTATION

The provisional restorations were removed and the teeth were cleaned using pumice. The final restorations were preceded by a try-on to verify the fit, shape, and shade. The intaglio surfaces of the feldspathic veneers were etched with 4.5 % hydrochloric acid (IPS Ceramic Etching Gel, Ivoclar, Schaan, Liechtenstein) for 1 minute (Fig. 29 a) to create micromechanical retention by removing the glass matrix. This etching process produces crystalline precipitates, which are insoluble in water (Fig. 29 b). The precipitates can be removed either by ultrasonic cleaning for 5 minutes or by etching with 35% phosphoric acid (Ultraetch, Ultradent, South Jordan, UT, USA) for 1 minute (Fig. 29 c). Failure in removing such residues might result in reduced bond strength to the ceramic intaglio surface.23,24 After rinsing and drying a silane coupling agent (Porcelain Silane, Premier Dental, Plymouth Meeting, PA, USA) was applied for 2 minutes. In consideration of an optimal long-term performance, a light cured, nano-filled composite material (Filtek Supreme Ultra, Shade CT, 3M ESPE, St. Paul, MN, USA) was used for cementation. In the oral cavity the cement at the margin is subjected to water sorption, subsurface degradation, wear, and discoloration.25 In comparison to methacrylate- or phosphate-based resin cements, preheated composites used as luting agents exhibited reduced deterioration by wear.26 Cements with smaller filler particle size and a higher filler load also showed less wear.23,24 Furthermore, unlike self- or dual-curing cements, light cured cements allow merely unlimited time for placement of the restoration and removal of excess cement.

For better handling during cementation the highly viscous composite must be pre-heated. Heating the composite reduces viscosity, improves flowability, and decreases film thickness.21 However, once removed from the heater the composite cools down quickly during handling and it might even cool down more rapidly if applied to a much colder restoration at room temperature, voiding the advantages of the pre-heating. Thus the restoration must be pre-heated as well. To avoid such a rapid temperature loss, the veneers were filled with a thin layer of the preheated composite (Fig. 30 a) and then placed into the composite heater until needed (Fig. 30 b).

The veneers were bonded one after another, beginning with the central incisors, followed by the canines, and lastly the premolars. While the composite loaded veneers were heated, a total-etch adhesive system (Optibond FL, Kerr, Orange, CA, USA) was applied to each tooth without light curing the adhesive yet. After placement of the restoration on the designated tooth and removal of excess luting agent, adhesive and composite were light cured for 40 seconds through a layer of glycerin gel to avoid the oxygen inhibited layer (Fig. 30 c). A scaler and scalpel were used to remove any excess adhesive and luting cement. Interproximal areas were finished with polishing strips (Sof-Lex Finishing Strips, 3M ESPE) and occlusion was checked and adjusted. To complete the rehabilitation, the insufficient class V restorations on the second premolars and first molars were replaced with a nano-hybrid composite (ENA HR, Synca, Le Gardeur, QC, Canada). Figure (31 a-g) show the successful shape transformation 2 months after delivery.

CONCLUSIONS

Esthetics can be defined in many different ways, but through the dental anatomical combinations of basic configuration of tooth anatomy, different types of teeth can be made that exalt the image in esthetic rehabilitation. It is necessary to know how to relate the surfaces one to another to achieve an aesthetic outline of the crown. Knowledge of the different dental structures and the ability to harmonize the teeth with the patient's

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(Fig. 31) a) Final smile with restorations b) Esthetic and functional integration of the veneers c-e) Occlusal views of the final result e-g) High magnification close look
face will lead the technician to create esthetically pleasing restorations. For a successful restoration, detailed planning and intensive communication between dentist and technician by the means of a preparation simulation and preparation guides are essential.

REFERENCES

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