IN BRIEF

- The shape, length and width of maxillary anterior teeth are open to interpretation, including mathematical, physiological and psychological.
- Tooth alignment, in three dimensions, creates a pleasing tooth-to-tooth progression.
- The position of the teeth in the dental arches also ensures correct phonetics and occlusion.

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VERIFIABLE CPD PAPER

Anterior dental aesthetics: Dental perspective

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The purpose of this series is to convey the principles governing our aesthetic senses. Usually meaning visual perception, aesthetics is not merely limited to the ocular apparatus. The concept of aesthetics encompasses both the time-arts such as music, theatre, literature and film, as well as space-arts such as paintings, sculpture and architecture.

ANTERIOR DENTAL AESTHETICS

1. Historical perspective
2. Facial perspective
3. Dento-facial perspective
4. Dental perspective
5. Gingival perspective
6. Psychological perspective*

* Part 6 available in the *BDJ* book of this series

INTRODUCTION

The dental perspective concerns the teeth, their shape, size, intra- and inter-arch relationships. The fourth paper in this series on anterior maxillary dental aesthetics discusses novel and redundant concepts for these dental elements. Numerous hypotheses have been postulated and dismissed emphasising, as with general principles of aesthetics, that empirical knowledge takes precedence over dogmatic scientific laws.

SHAPE

The morphology of maxillary anterior teeth is a fusion of the three basic shapes: circle, square and triangle (Fig. 1). These shapes are analogous to the primary colours (red, green and blue), from which any colour can be created. Similarly, any shape can be created from a circle, square or triangle. The unique composite morphology of the teeth allows diversity and individuality. Essentially, no two teeth are ever alike, but all share the same geometric building blocks. This configuration has allowed nature carte blanche to produce inimitable shapes based on only three variables. Emphasising one shape and suppressing the others, has promoted manufacturers of artificial teeth for dental prostheses to classify teeth as circular, rectangular or triangular.

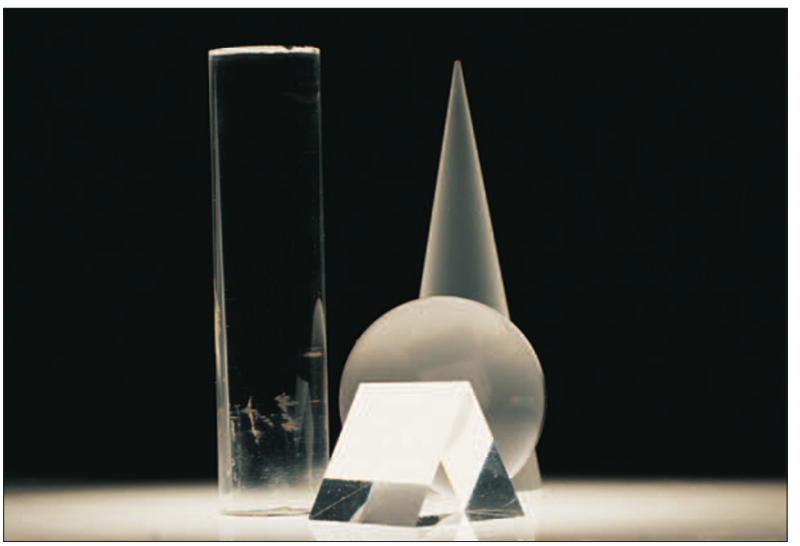

Fig. 1 The three basic shapes circle, square (rectangle) and triangle

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The shape of the maxillary anterior teeth has been the subject of numerous studies. The most prominent are by Williams[1] and Frush and Fisher.[2-4] Williams proposed that the shape of the central incisor was the inverted frontal view of the face, while Frush and Fisher suggested that sex, age and personality related to the contour of the anterior dental segment. Williams' theory was invalidated by subsequent studies.

Fig. 2 Maxillary central incisors with worn incisal edges, conveying an aged dentition

Fig. 3 Virgin maxillary central incisors with pristine unworn incisal edges and developmental lobes

Fig. 4 Feminine teeth: Curvaceous outlines, devoid of shape line angles. Also, notice the mesial inclination of the lateral incisors

Fig. 5 Masculine teeth: Rugged outline, dominance of the central incisor and distal inclination of the lateral incisors (compare with Fig. 4)

The Frush and Fisher concept is concerned with the dominance of the central incisors and their wear in advancing years. It is worth noting that the chronological age of a patient might not coincide with the dental age. In cases where a patient has pronounced wear, either by local or systemic causes, the dental age may be greater than the chronological age (Fig. 2). The opposite is evident for older individuals with sharp incisal edges and pronounced incisal embrasures, conveying a youthful dental appearance (Fig. 3). Other theories have proposed correlating tooth shape with skeletal and soft tissue landmarks, but these ideas have proved inconclusive. The shape of teeth is genetically determined and the prosthodontist should, if possible, obtain pictures of a patient's relatives before determining the shape of the definitive prosthesis.

If no records are available, the points to consider are age, sex, race, and personality. For example, youthful teeth are sharp, having unworn incisal edges; with the central incisors dominating the composition, and in harmony with the laterals and canines. The reverse is true for an older dentition, ie blunt incisal edges and wear and attrition without conclusive dominance of the maxillary central incisors. Sociologically, stereotypes are readily recognised and associated with specific individuals. These divisions are culturally specific and relevant to a particular country or demographic locality. For example, it is generally recognised that females display curvaceous features (both facially and bodily), devoid of sharp line angles. On the other hand, masculinity is associated with ruggedness and sharp line angles. The process of transposing these gender variations onto the shape of the teeth (Figs 4 and 5) is a concept termed morphopsychology (see part 2: Facial perspectives).

Finally, personality is significant for perception of an individual in society. A gregarious, vivacious persona is linked to an effervescent personality, while a sombre, reclusive character is perceived as bland and unsociable. Once again, these stereotypes are influenced by upbringing, intellect, culture, and theology. Linking these traits to dental morphology is conforming purely to society's perception of an individual. Making teeth, which are bright, bulbous, and prominent, are appropriate for an outgoing person. Conversely, teeth that convey subtlety with a lower value, and hence are less conspicuous, may be more suited to an introvert.[2] Personality traits are discussed further in the sixth and final article entitled Psychological perspective, which looks at the psychological influence of our cerebral perception to the dentition.

SIZE

Tooth size is determined by mesio-distal width divided by the inciso-gingival length, which yields the width/length (w/l) ratio (Figs 6 and 7):

$$\text{width/length (w/l) ratio of a tooth} = \frac{\text{width}}{\text{length}}$$

No definitive value for the w/l ratio exists and experts dispute its value. The mesio-distal width is more important than the inciso-gingival length[3] and the former measurement has attracted much debate. Research has focused on measurements of extracted teeth, racial and gender differences, together with facial landmarks such as the bizygomatic width. House and Loop[4] postulated that the mesio-distal measurement of the central incisor was 1/16 of the bizygomatic width. Other studies have also sought to assign geometric values for the mesio-distal width of the centrals, eg 1/16 of the face height or the width of the iris.[5]

There are two schools of thought regarding the size of the maxillary central incisors. The first is by Rufenacht[6] who proposed morphopsychological determination of an ideal proportion, and suggested that the width and length of the central incisor should be constant throughout life. This view relies on the philosophical notion of eternal youth as described by French writer Robert Brasillach who said, 'in life only one youth exists and we pass the rest of our days regretting it'. While this statement may seem romantic, many regard it as sacrosanct and seek a myriad options to stave off our 'final destination'. Bearing this in mind the clinician's role is not to act as judge, but as a conduit for patients' desires. If a person seeks such an option, the dental team should try not to deny a patient's wishes.

The second theory states that our bodies are in perpetual change throughout life. We are born small, become taller, and eventually lose height in advancing years. Our skin has tone and suppleness in youth but becomes flaccid and dull as we grow older. The dentition is no exception to this transformation. When the central incisors erupt, they are pristine with defined incisal lobes, a textured surface roughness, bright enamel, with a smaller w/l ratio (Fig. 8). During normal functioning, excluding the effects of disease, the incisal edges wear (resulting in a larger w/l ratio), surface texture becomes smooth, and the enamel dulls due to increased translucency (Fig. 9). These processes are congruous with the ageing of the rest of the body. Creating teeth with a youthful appearance is discordant in an older person and creates a sense of artificiality.

The evidence behind each theory is inconclusive and each concept is still open to discussion. Furthermore, the overriding factor in any case is a patient's wish including their perception of themselves in society. Nevertheless, general guidelines are useful for creating a pleasing result.

Fig. 6 Measuring the mesio-distal width of the central incisors with callipers

Fig. 7 Measuring the inciso-gingival length of the central incisors with callipers

Fig. 8 Youthful teeth: Textured surface roughness, visible perikymata and bright enamel

Fig. 9 Aged teeth: Smooth surface roughness, stained fracture lines and a low value, dull enamel overlay

Firstly, the w/l ratio of the central incisor should range from 0.75 to 0.8, a value less than 0.6 creates a long narrow tooth, and beyond this number results in a short wide tooth

Fig. 10 Width/length ratio (w/l): the blue tooth has a w/l ratio of 0.8, the red ('ideal') 0.75, and the green 0.6

(Fig. 10). Secondly, the central incisor should be the dominant element in the anterior dental composition (Fig. 11). Lastly, the vertical overbite in relation to speech and anterior guidance needs addressing (Fig. 12). Besides these fundamental principles, subtle variations can be introduced which account for gender, race, facial, morphopsychological, and psychological factors.

The buccolingual thickness shows wide variance, ranging from 2.5 mm to 3.3 mm for the maxillary central incisors.[7] The thickness is measured with a width gauge, at the junction of the middle third and incisal third of a tooth (Fig. 13). For a crown, if a reading of more than 3.5 mm is apparent, then over-contouring of the prosthesis is suspected, usually because of under-preparation by the clinician leaving the ceramist inadequate room for the porcelain layer build-up, resulting in a bulbous crown. If the thickness of a tooth is less than 2.5 mm, elective endodontic therapy may be necessary to achieve the desired aesthetics. In cases where a tooth is inclined facially or lingually, and the proposed prosthetic treatment is to simulate its location beyond 2 mm, interceptive orthodontic therapy may be mandatory.[8]

Fig. 11 The dominance of the central incisor is paramount for pleasing anterior maxillary aesthetics

Fig. 12 Overbite assessment of two crowns on the maxillary central incisors

Fig. 13 The Bucco-lingual thickness is measured at the junction of the middle third and incisal third of a tooth (depicted by the green line)

INTRA-ARCH RELATIONSHIP

Having established guidelines for shape and dimensions of the maxillary anterior segment, and in particular that of the central incisor, the next point to consider is the relationship between incisors and canines. The tooth-to-tooth relationship frequently relies on the Divine (or Golden) proportion and dynamic symmetry, initially proposed by the ancient Greeks.

In 530BC Pythagoras suggested beauty could be defined as an exact mathematical concept, which led to the Divine or Golden proportion (1/1.618=0.618). Similarly, Plato proposed the Beautiful proportion (1/1.733=0.577) as the quintessential ratio for beauty. Both ideas stated that an object with these proportions had innate beauty. The most widely used concept in dentistry is the Golden proportion – where S is the smaller and L the larger part:

$$\frac{S}{L} = \frac{L}{S+L} = \frac{2}{1+\sqrt{5}} = 0.618$$

The uniqueness of this ratio is that when applied by three different methods of calculations, linear, geometric and arithmetic, the proportional progression from the smaller to the larger to the whole part always produces the same results. Lombardi[9] and Levin[10] have transposed this ratio to the maxillary anterior sextant (Fig 14). Other researchers[11] have indicated that clinically the Golden proportion is not always

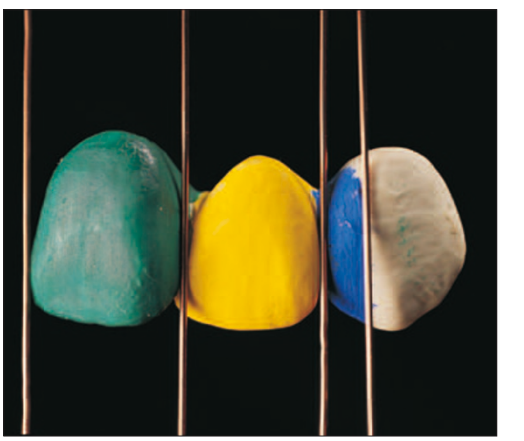

Fig. 14 The Golden proportion relates to the mesio-distal widths of the central and lateral incisors and the mesial aspect of the canine

evident and variations are often apparent. In one study, measurements of plaster casts of natural teeth revealed that only 17% conformed to the Golden proportion.[12] This begs the question that if only some teeth conform to this rule, which ratio is prevalent for the rest of the population? Although the Golden proportion is invaluable as a starting point for aesthetic appraisal, the reality is that any ratio from 0.6 to 0.8 is aesthetically acceptable. The salient points to consider are harmony, balance, morphopsychology, and psychology.

Firstly, to create harmony the chosen ratio should be repeated moving distally from the central, to lateral incisors, to the canines. Harmony relies on similar repeated proportions, rather than the actual size of the elements (Figs 15-17). For example, if an individual has a large nose, small eyes and thin lips, the face will lack harmony because the nose will predominate. However, large eyes, full lips, and a large nose will blend harmoniously with the rest of the face.

Fig. 15 Harmony: narrow repeated proportions of anterior maxillary sextant (0.6 w/l ratio – small)

Fig. 16 Harmony: 'ideal' repeated proportions of anterior maxillary sextant (0.75 w/l ratio)

Fig. 17 Harmony: wide repeated proportions of anterior maxillary sextant (> 0.8 w/l ratio)

Secondly, the right and left sides of the maxillary sextant should be balanced. If the right lateral incisor is lingually inclined or rotated in relation to the arch, the contralateral lateral should show a similar misalignment to create a balanced look (Figs 18-20). An example of the latter scenario is evident in patients with Angle's Class II, division II occlusion (Fig. 21).

Fig. 18 Balance: lingually inclined right lateral incisor with a similar contralateral misalignment (facial view)

Fig. 19 Balance: lingually inclined right lateral incisor with a similar contralateral misalignment (occlusal view)

Fig. 20 Balance: mesio-buccal rotations of the right and left lateral incisors

Fig. 21 In an Angle's Class II, division II occlusion, the mesial aspect of the lateral incisor facially overlaps the distal aspect of the central incisor

Lastly, morphopsychological and psychological factors can influence the chosen ratio for the tooth-to-tooth relationship. For example, if the intention is to convey masculinity by choosing a larger recurring ratio in a small arch, a disto-facial imbrication of one or more teeth in the maxillary anterior segment resolves the predicament. Conversely, a mesio-facial imbrication conveys

femininity with a narrow maxillary arch form. To summarise, the paramount issue for gaining aesthetic approval in a composition is ensuring harmony and balance, irrespective of size or ratio.

Another aesthetic marker is the axial inclination of the upper anterior teeth. Ideally, a mesial axial inclination seems to attract aesthetic approval, while a distal one conveys visual tension. One explanation why a mesial inclination, as opposed to distal one, invokes a sense of aesthetic approval (Fig. 22) is that the curvature of an object (convex or concave) is important to the way it is perceived. Concavity conveys receptiveness and belonging, while convexity the opposite, eg pushiness and aggression. An example is a relaxed smile when the concavity of the maxillary incisal plane is parallel to the concavity of the mandibular lip. Both these concavities are perceived as welcoming and receptive, which after all, is the purpose of a smile. In a similar manner, mesial axial inclination forms a concave curvature, also conveying receptiveness and belonging. Further enrichment of the anterior dental segment is created by ensuring that the interproximal contact points coincide with the incisal edges, and the curvature of the mandibular lip, enhancing the cohesiveness of the dentofacial composition.

Incisal embrasures have a distinct appearance depending on age and sex. For virgin teeth, soon after eruption, the embrasure angle increases anterior-posteriorly from the maxillary incisors to the canines (Fig. 23). As a generality, pronounced embrasures convey youthfulness and femininity, while shortened, worn edges convey ageing and masculinity (Fig. 24). The clinician should be guided by patient preferences, age and gender before prescribing precise incisal embrasure angles for artificial restorations.

Fig. 22 A mesial axial convergence of the anterior teeth is conducive for aesthetic approval

Fig. 23 Sharp, well-defined incisal embrasures, with increasing anterio-posterior angles

Fig. 24 Blunt, worn incisal embrasures, with constant anterio-posterior angles

INTER-ARCH RELATIONSHIP

Horizontal and vertical overbite depends on the inciso-gingival length of the anterior teeth (both maxillary and mandibular), the shape of the arches, and angulations of the teeth in the sagittal plane. In ideal circumstances, the maxillary central incisors are 12 mm long, perfectly aligned and the arch form is within the norm, with the mandibular central incisor 10 mm long. In this case, the vertical overlap and horizontal overlap are 4 mm and 2 mm, respectively. Furthermore, with this ideal overbite and overjet, the occlusal vertical dimension (OVD) is 18 mm, measured from the gingival zeniths of the maxillary and mandibular central incisor.

Once again, these utopian clinical presentations are rare. To establish a correct inter-arch relationship, the starting point is the location of the maxillary central incisor edge position with the lips at rest, and during a relaxed smile (Figs 25 and 26).

During these two soft tissue positions, the incisal edges are assessed, and influenced by three variables. The first is aesthetics. Ideally, the maxillary incisal edges should be parallel to the curvature of the mandibular lip. The second issue is to ensure that phonetics are not compromised. In the sagittal plane, when the 'f' and 'v' sounds are spoken, the buccal surfaces of the maxillary incisors should contact the inner or mucosal surface of the mandibular lip (Fig. 27). If these teeth encroach on the cutaneous part of the mandibular lip, this indicates either an overcontoured, or bulbous restoration or incorrect tooth angulations. Lack of contact with the lower lip indicates shortened or incorrectly aligned maxillary incisors. The 's' sound determines the vertical dimension of speech, characterised by an unimpeded edge-to-edge position of the maxillary and mandibular incisors. Finally, during a 'th' sound, the tongue should make contact with the palatal surfaces of the maxillary incisors.

Fig. 25 Assessment of incisal tooth exposure with the lips at rest

Fig. 26 Assessment of incisal tooth exposure during a relaxed smile

The third determinant of the incisal edge position is the anterior guidance, often ignored at the expense of aesthetics, resulting in ultimate failure of restorations due to unwanted protrusive interferences.

CONCLUSION

The teeth, as with the other perspectives of dental aesthetics, display variance and nuances, showing individuality in a given dentition. This article has tried to present old and new concepts on tooth morphology, size and their relation to each other. In conclusion, no single aspect can be accredited with successfully arriving at the final shape and dimensions of the maxillary anterior teeth. The clinician and ceramist ultimately rely on their experience and observations, combined with patients' desires, for creating functioning and aesthetically pleasing prostheses.

Fig. 27 Correct phonetics and incisal inclination: during 'f' and 'v' sounds of speech, the buccal surfaces of the maxillary central incisors touch the inner, or mucosal, surface of the mandibular lip

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