

IN BRIEF

- The results of this study suggest that the 'golden proportion' should not be a single value but rather a range.
- Hypodontia patients showed a preference to a longer lateral incisor as compared to the other groups.
- What is aesthetically pleasing to the clinician and patient may not be the same.
- Communication and presentation of all diagnostic information to the patient is essential when undertaking treatment planning.

VERIFIABLE
CPD PAPER

The influence of varying maxillary lateral incisor dimensions on perceived smile aesthetics

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Objective The aim of this study was to determine the influence of varying the dimensions of the maxillary lateral incisors on perceived smile aesthetics.

Design Clinical study.

Setting Postgraduate dental teaching hospital.

Methods A photograph of a female smile displaying only the lips and teeth was digitally altered. First, the width of the maxillary lateral incisors, in proportion to the central incisor, was altered at 5% intervals to produce six images (52%, 57%, 62% [the 'golden proportion'], 67%, 72% and 77%). In a second group, the length of the lateral incisor was altered at 0.5 mm increments to produce five images with the lateral incisor 0.5 mm, 1 mm, 1.5 mm, 2 mm and 2.5 mm shorter than the adjacent central incisor. The photos were ranked from 'most attractive' to 'least attractive' by 41 hypodontia patients, 46 non-hypodontia 'control' patients and 30 dentists.

Results: The 67% followed by the 72% lateral-to-central width proportions were the 'most preferred' by all groups. A maxillary lateral incisor that is 1–1.5 mm shorter than the central incisor was the 'most popular' maxillary lateral incisor length. The very short and very long maxillary lateral incisor was consistently perceived as 'least attractive'.

Conclusion There is no evidence to suggest that the golden proportion should be considered the ideal aesthetic standard when creating space for the replacement of missing lateral incisors.

INTRODUCTION

An aesthetic smile is highly compromised by absent or malformed anterior teeth, which subsequently can affect the appearance, personality and psychological well being of an individual.^{1,2}

Hypodontia, the developmental absence of teeth, is the most common dental developmental problem in humans.³ Excluding the third molar, population prevalence across the world varies between different continents and is reported to be between 2.5% and 6.9%, with females being 1.37 times more susceptible than males.⁴ Excluding the third molar, Polder's meta-analysis study showed that the mandibular second premolar was the most frequently absent tooth, followed by the maxillary lateral incisor and the maxillary second premolar.⁴ Hypodontia in the anterior region is likely to have the most repercussions on dental aesthetics and the smile. Patients with congenital absence of maxillary lateral incisors present a significant challenge in achieving ideal smile aesthetics.

Three main treatment options exist for the management of congenitally missing maxillary lateral incisors. These options include accepting the space, orthodontic space closure with substitution of the lateral incisor by the canine, or opening the space for tooth replacement.^{5–10} Currently, osseointegrated implants are the preferred treatment alternative by many dentists for replacing missing anterior teeth.¹⁰

Many patients with congenitally missing maxillary lateral incisors lack sufficient space for ideal restoration. This is often due to the mesial eruption of the adjacent canine into the lateral incisor space. There are three methods to determine the ideal amount of space to create for a missing lateral incisor if this is the chosen treatment option.¹¹ Firstly, the contra-lateral lateral incisor tooth, if present and of normal width, is an ideal guide to establish the space required for the missing lateral incisor. The second method involves using the 'Bolton

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Fig. 1 Six variations of the image presented in Figure 2 c with the width of the maxillary lateral incisors being adjusted in proportion to the central incisors to produce six optical proportions, namely 52% (a); 57% (b); 62% 'golden proportion' (c); 67% (d); 72% (e); and 77% (f)



Fig. 2 Four variations of the image presented in Figure 2 c with the incisogingival length of the maxillary lateral incisors being adjusted relative to the incisal edge of the central incisors to produce four different incisal levels, namely -2.5 mm 'S2'(a); -2 mm 'S1' (b); -1.5 mm 'N' (standard length) (c); -1 mm 'L1'(d); and -0.5 mm 'L2'(e)

analysis';¹² a mathematical formula used to analyse the mesio-distal tooth width ratios between mandibular and maxillary teeth to achieve an ideal occlusal relationship.^{12,13} The Bolton ratio is calculated by dividing the sum of the mesio-distal widths of the six mandibular anterior teeth by the sum of the mesio-distal width of the six maxillary anterior teeth, which gives a ratio of approximately 0.78. This ratio can be used to mathematically calculate the width of the congenitally missing maxillary lateral incisor. The third method to determine the ideal amount of space to create is by considering anterior tooth proportion. Clinicians have often used the so-called 'golden proportion' as a guide to determine the ideal amount of space to create for incisor replacement. The 'golden proportion' implies using a golden ratio (≈ 0.61803) in the arrangement of the maxillary teeth from the frontal view.

The perceived size of the smaller subject is about 62% of the larger subject, when viewed from the front.^{14,15} In dentistry, Levin,¹⁴ and more recently others,^{16,17} designated the 'golden proportion' as the most harmonious recurring tooth-to-tooth ratio, with very little evidence in the dental literature to support this view. On the contrary, some reports showed that the majority of what were agreed upon as beautiful smiles did not show evidence of occurrence of the golden proportion.¹⁸⁻²⁰ Moreover, the golden proportion was absent in the majority of normal dentitions.^{21,22}

The aim of this study was to determine the influence of varying the size of the maxillary lateral incisors on perceived smile aesthetics.

MATERIALS AND METHODS

A photograph of a smiling female displaying only the lips and teeth was digitally manipulated with computer software (Adobe® Photoshop® CS2 software; Adobe Systems Inc, San Jose, CA) to produce a standardised image that was bilaterally symmetrical and encompassed most of the objective dental and gingival criteria of aesthetic principles. Using the measuring tool on Photoshop image processing software, the dimensions of the maxillary lateral incisor were digitally altered to produce two different sets of photos. In the first set, the width of the maxillary lateral incisors, in proportion to the central incisor, was altered at 5% intervals to produce a total of six images, namely 52%, 57%, 62% (the 'golden proportion'), 67%, 72% and 77% (Fig. 1). In the second set, the length of the lateral incisor was altered at 0.5 mm increments to produce a total of five images with the lateral incisor 0.5 mm (L2), 1 mm (L1), 1.5 mm (N), 2 mm (S1) and 2.5 mm (S2) shorter than the adjacent central incisor (Fig. 2). All alterations were selected after the conduction of a pilot study to determine the sensitivity to the changes made. Participants in the pilot study showed sensitivity to as low as 5% change in proportion of the maxillary lateral incisors relative to the central incisor and about 0.5 mm change in length.

Photographs were professionally printed (4 × 6 inch) with a matt finish. Each photograph was ascribed by an exclusive symbol on its posterior surface as a code for identification when tabulating the results. Participants were asked to ignore any identifiable mark on the pictures.

One hundred and seventeen participants, 41 radiographically confirmed hypodontia patients (21 female and 20 male), 46 non-hypodontia 'control' patients (26 female and 20 male) and 30 dentists (11 female and 19 male), were enrolled. Each participant was interviewed separately and consented to participate. All of them took part voluntarily and were unpaid. Ethical approval was obtained from the joint University College London (UCL) and University College London Hospitals (UCLH) ethics committee.

Each participant was asked to rank each set of photos from the 'most attractive' to the 'least attractive'. The task was completed by each participant in similar lighting conditions and time period. Participants were allowed 15 seconds for each photograph and an additional 30 seconds at the end to verify their choices. They were allowed to move and organise the photographs until they had achieved a definite rank order provided they had not exceeded the assigned time. At the end, each participant was asked if he/she was able to identify any

difference between the images. The ability of the participants to detect changes to the dimension of maxillary lateral incisors was recorded as 'YES' or 'NO'.

In this study we proposed a new method to test the 'intra-observer' reliability. Using a randomly selected 'duplicated' image of each set, for a result to score as 'reliable', the assessor had to be able to either arrange the duplicates side-by-side, or arrange the duplicate at least one position apart. This later condition was scored as reliable *only if* the intermediary image was 5% wider or narrower than the control for the width modification groups and 0.5 mm longer or shorter for the length modification group. We decided on an acceptable reliability level of 70%. This is an arbitrary setting adopted from the Cronbach's alpha which is the most common form of internal consistency reliability coefficient used in cognitive tests. By convention, a lenient cut-off of 0.70 is common in alpha and considered as an 'adequate' scale. The validity of this study is purely determined by scoring optimal reliability levels indicating a high level of consistency and awareness.

Data were analysed using 'SPSS' software for Windows (version 12.0; SPSS Inc, Chicago, IL, USA). Descriptive and series of global and *post-hoc* non-parametric statistics (Chi-square test (χ^2)) for independent samples were used to analyse the data. The critical level of significance was set at p value ≤ 0.05 .

RESULTS

Effect of modifying 'width' of maxillary lateral incisors on perception of smile aesthetics

The choices of the 'most attractive' smiles were compared between the three different groups (Fig. 3). Analysis was performed at two different stages. First, the overall perception of what was achieved as most attractive was compared between groups using a global statistical analysis. Then, significantly different overall views ($p \leq 0.05$) between each combination of pairs of groups, were tested with a series of *post-hoc* multiple comparison tests, at each level of variation, to identify the variable contributing to the difference and to identify the 'most attractive' arrangements in width settings.

Results showed significant differences between hypodontia patients and dentists ($p = 0.01$) and between normal 'control' patients and the dental professionals ($p = 0.006$). However, no difference was found in the overall view of what was perceived as 'most attractive' between the hypodontia and control patients ($p = 0.66$).

Smiles with 67% lateral-to-central incisor width proportion were perceived as 'most appealing' by 36.6% of the hypodontia group, 30.6% of the control group and 50% of the dental professionals group. Subsequently, smiles with 72% lateral-to-central width proportion were perceived as 'most appealing' by 17.1% of hypodontia participants, 18.6% of control participants and 43.3% of dental professionals (Fig. 3).

Post-hoc multiple comparison tests showed that the 67% width ratio followed by 72% width ratio were significantly preferred to all other ratios ($p = 0.0001$ and 0.002). Although there was a difference in the overall perception of the 'most attractive' smile, there was no difference between all groups in perceiving these two ratios as being the 'most popular' ($p = 0.6$).

On the other hand, the 52% lateral-to-central width proportion was the 'least favoured' by 46.3% of hypodontia patients, 39.5% of control participants and 80% of dentists (Fig. 4).

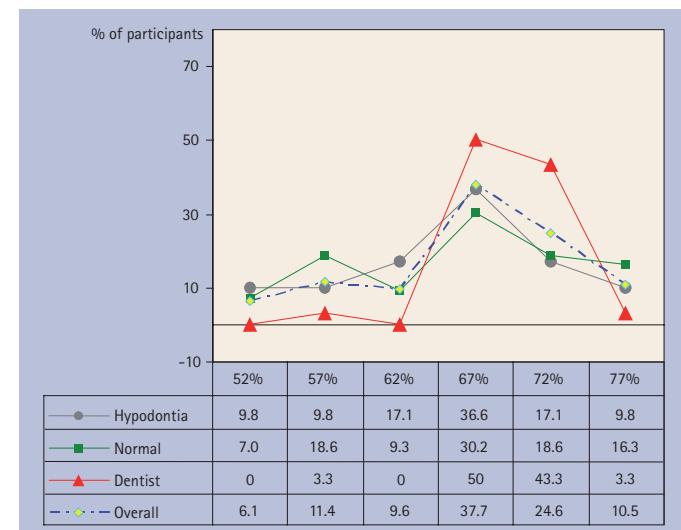


Fig. 3 Perception of 'most attractive' smile following changes to width of maxillary lateral incisor

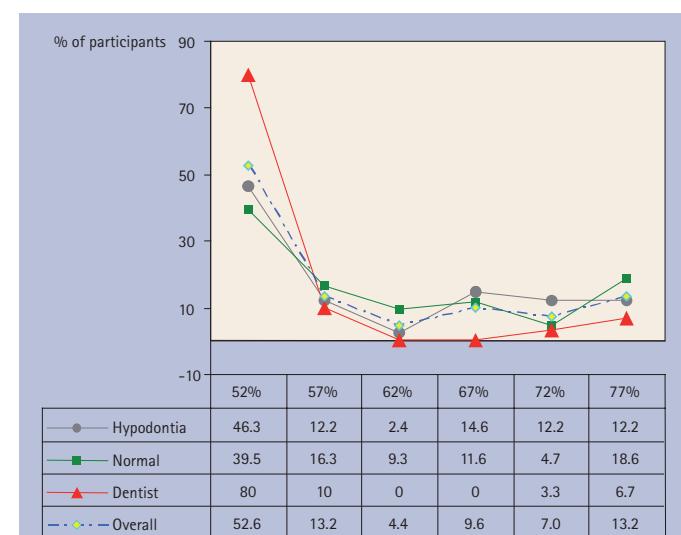


Fig. 4 Perception of 'least attractive' smile following changes to width of maxillary lateral incisor

Post-hoc multiple comparison tests showed that although there was fairly general agreement to what was perceived as the 'least attractive' arrangement, dentists seem to be more consistent in perceiving the 52% width proportion as 'least attractive' than both hypodontia and normal 'control' patients ($p = 0.02$ and 0.002, respectively).

In general, it was clear that the so-called 'golden proportion' was not the 'most appealing' arrangement, as perceived by the majority of participants (Fig. 3). Moreover, a certain proportion of participants thought it was the 'least appealing' (Fig. 4). None of the dentists rated this proportion as 'most appealing' (Fig. 3).

The validity of these choices was confirmed to an acceptable degree of reliability for all groups according to the aforementioned criteria. The hypodontia group showed 82.9% reliability, whereas the reliability of the control group was 79.1%. The dental professionals, on the other hand, showed a remarkably higher reliability (93.3%), but there was no statistically significant difference between the reliability of all groups overall ($p = 0.20$).

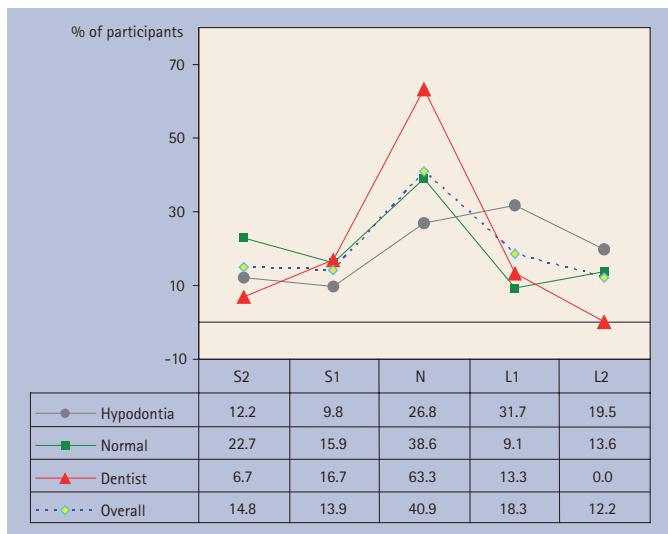


Fig. 5 Perception of 'most attractive' smile following changes to length of maxillary lateral incisor

Effect of modifying 'length' of maxillary lateral incisors on perception of smile aesthetics

The overall perception of the 'most popular' smiles following changes in the length of the maxillary lateral incisor (Fig. 5) was significantly different between hypodontia patients and dentists ($p = 0.005$), and between control patients and the dental professionals ($p = 0.05$, chi-square test). However, no difference was found between hypodontia and control patients ($p = 0.07$).

Post-hoc multiple comparison tests showed that, overall, an anterior dental arrangement with the maxillary lateral incisors 1.5 mm shorter than the adjacent central incisor (N, Fig. 2) was perceived as 'most attractive' by 26.8% of the hypodontia patients, 38.6% of the control patients and 63.3% of the dentists, with the dental professionals being more consistent in their choice ($p = 0.001$). Moreover, smiles with 1 mm shorter lateral incisors (L1, Fig. 2) were perceived as 'most appealing' by 31.7% of hypodontia participants. Control patients and dentists perceived this length with much less interest ($p = 0.001$).

There was a general agreement that smiles with both the longer (L2) and the shorter arrangements (S2) were equally perceived as 'least attractive' (Figs 2 and 6), with no difference in the overall profile of what was perceived as 'least attractive' between all groups ($p = 0.1$).

Validity of this set of results was confirmed by an acceptable reliability level for all groups (73.2% for hypodontia patients, 75% for the normal patients and 96.7% reliability for dentists). Dentists were significantly more reliable than hypodontia and control patients ($p = 0.008$ and 0.013, respectively).

Effect of the ability to identify the changes on reliability and perception of 'most and least attractive' smiles

Participants were asked at the end of the task if they could specify any differences between the displayed images and if that influenced their choice. Their response was recorded as 'yes' if they had picked up the width modification and 'no' if they had not. Results showed 31.7% of the hypodontia patients, 30.4% of the control patients and 66.7% of the dental professionals were able to identify the changes in 'width' of the

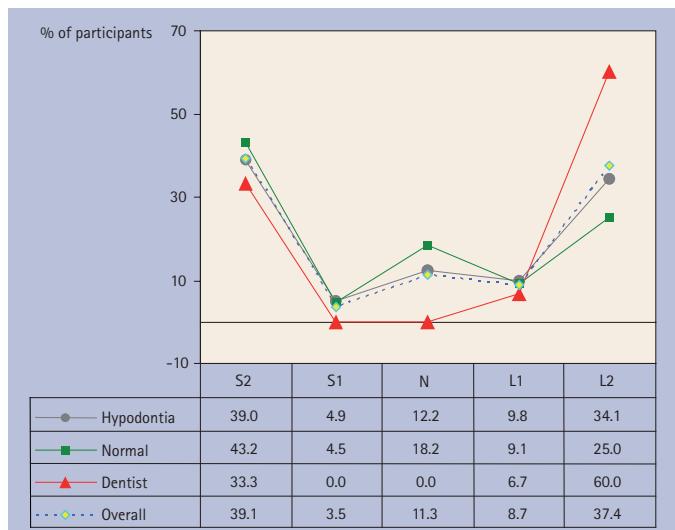


Fig. 6 Perception of 'least attractive' smile following changes to length of maxillary lateral incisor

lateral incisors. Correspondingly, 36.6% of the hypodontia patients, 36.4% of the control patients and 70% of the dental professionals were able to identify the changes in 'length' of the lateral incisors.

The dental professionals were significantly more likely to detect both changes in width and length as compared to both hypodontia patients and the control patients ($p = 0.003$ and 0.002, respectively, for width changes and 0.005 and 0.044, respectively, for length changes). Results showed no difference between the ability of hypodontia and control participants to identify the length modifications ($p = 0.9$ for width changes and 0.6 for length changes).

Results showed that even though some of the participants were not able to detect the changes in width of the lateral incisors, their ability to arrange the duplicate image side-by-side was not influenced ($p = 0.23$ for width changes and 0.30 for length changes).

Moreover, results showed that the ability to detect the width modifications did not influence the perception of the 'most attractive' smile ($p = 0.23$) but it did affect the perception of 'least attractive' smile. Participants who chose 52% width proportion arrangement as the 'least attractive' smile were significantly aware of the changes ($p = 0.002$).

The ability to detect the length modifications significantly affected the perception of both 'most and least attractive' smiles ($p = 0.003$ and 0.0001, respectively). In other words, participants who chose N as the 'most attractive' setting and those who chose S2 and L1 as the 'least attractive' smiles were significantly more likely to be aware of the changes.

Effect of gender

When participants from all groups were allowed to evaluate the images with the width of the maxillary lateral incisor modified, the male participants were equally reliable as compared to the female participants in the hypodontia group. The normal 'control' male participants were significantly more reliable than the female participants from the same group ($p = 0.03$). Moreover, no difference was detected in reliability of both female and male participants in the dental professionals group.

DISCUSSION

In an attempt to reduce subjectivity and increase objectivity, several studies have assessed smile aesthetics by employing judgment panels. The judgment panels included dental volunteers, art specialists and laypersons. Among these are studies carried out to evaluate the optimal proportion of the anterior dental arrangement.^{19,20,23} The one common objective of these studies was to attempt to define guidelines for anterior dental aesthetics that are approved by the population sector receiving the treatment. None of these studies investigated the perception of a hypodontia group, a main target for aesthetic dental treatment. The views of hypodontia patients may differ from those of the general population as this group maybe more dentally aware. Hence, for the purpose of this study, patients with hypodontia were specifically targeted to determine their views about smile aesthetics.

Within the dental literature, unattractiveness was related to outstandingly narrow lateral incisors with an estimated proportion of 28–39%²³ and 43%.²⁰ As compared to other studies which set their lower range at the 62% ‘golden proportion’,¹⁹ we decided to set our lower limit at 52% to avoid bias in the lower range and to check if there are other preferred proportions lower than 62%. From that, width was modified at 5% intervals. This was decided upon based on the results of our pilot study in which 10 out of 12 participants were able to detect changes in proportion as small as 5%.

Our lower limit was set at 10% less than the 62% ratio, so logically, we wanted to set our upper limit at a similar interval. However, the upper limit from other studies was set at much higher intervals: 80%¹⁹ and 87%.²⁰ To reach a compromise between these factors, we set our higher limit at 77%, that is 15% higher than the 62% value.^{19,20}

In similar research, reliability has been tested using the ‘test-retest’ reliability method, where the same test is repeated on the sample on two different occasions and a correlation is derived.²⁰ However, the correlation between two observations may be dependent on how much time elapses between the two measurements because of the effects of memory. To get round this, we used a new method to measure the reliability within each group. This required participants to arrange two duplicate images side by side at one sitting. We acknowledged that even if the two duplicates were one position apart, the results would be considered reliable, as the intermediary image was \pm 5% for the width modified images and \pm 0.5 mm for the length modified images.

We decided on an acceptable reliability level of 70%. This is an arbitrary setting adopted from the Cronbach’s alpha, which is the most common form of internal consistency reliability coefficient used in cognitive tests. By convention, a lenient cut-off of 0.70 is common in alpha and considered as an ‘adequate’ scale. The validity of this study is purely determined by scoring optimal reliability levels indicating a high level of consistency and awareness. Based on the aforementioned criteria, validity of the choices of the ‘most and least preferred’ smiles was acceptable for all the groups ($\geq 70\%$).

Although dentists showed higher levels of reliability, their reliability was significantly higher only when assessing ‘length’ modifications of the maxillary lateral incisors as compared to both hypodontia and normal ‘control’ patients ($p = 0.008$ and 0.013 , respectively). It is not surprising to find that dentists are

significantly more reliable than non-dental participants. One possibility as to why the reliability of the dentists was significantly higher than that of both the hypodontia and the normal ‘control’ groups is that the non-dental groups were less sensitive to changes in length compared to width. This agrees with the findings of Kokich *et al.* who showed that laypeople were less perceptive to crown length discrepancy, as well as incisal plane asymmetry, than dental professionals.²³

In the past, the ‘golden proportion’ has been applied to the relative widths of the maxillary anterior teeth to establish ideal aesthetics. One of the first to describe the golden proportion and its importance in restorative dentistry was Lombardi.¹⁵ Since then, others, including Levin¹⁴ and Qualtrough and Burke,¹⁷ have reinforced its application to anterior aesthetics. The so-called ‘golden proportion’ is commonly used as a guideline to determine the space required for restoring anterior teeth.¹⁶

In the dental literature, Preston confirmed the unrealistic nature of the golden proportion.²² The golden proportion was rarely found between the maxillary anterior teeth of 58 dental casts when viewed from the front.²² Nor did it exist in the anterior arrangement of 100 Turkish dental students.¹⁸

Our results, combined with the results of others, provide evidence that the ‘golden proportion’ is by no means the most popular arrangement.^{19,20,23} Only 17.1% of the hypodontia group perceived this proportion as ‘most attractive’, as compared to 2.4% of the control group. More importantly, none of the dentists rated the ‘62% – golden proportion’ as the most attractive. Similarly, other studies showed that the golden proportion was not perceived as the ‘most’ aesthetically pleasing by dentists,^{18–20} nor by lay people.²⁰

There is an increasing body of evidence rejecting the golden proportion, however it is still premature to draw such a conclusion, particularly because there are minor groups who still consider this proportion as ‘most pleasing’. Additionally, Wolfart *et al.* showed that the ‘most appealing’ proportion is rather a range between 50–74% as perceived by lay people and between 56–68% as perceived by dentists. These proportions were inclusive of the proposed 62% golden proportion.²⁰

Our results showed that all groups perceived the lateral-to-central incisor width proportions 67%, followed by 72%, as the ‘most popular’ proportions. These results bear similarity to those of Rosenstiel *et al.*¹⁹ Only when the length of the maxillary incisor teeth lies within the normal range, was the ‘best width proportion’ equally distributed between 70–80% proportions. According to Rosenstiel *et al.*, the 62% width proportion was chosen as ‘best arrangement’ only when the incisor teeth were ‘very long’ (20% longer than normal length).¹⁹ This might account for the similarities between the two sets of results. On the other hand, Wolfart *et al.* provided a range that the results from our hypodontia and normal patients would fit into it, but not those of the dentists.²⁰ Their results showed that the ‘most attractive’ maxillary lateral-to-central incisor proportion rated by medical students and lay people was within the range of 50–74% or within 56–68% for dentists. Some would expect such diversity in the proportions, as the issue of aesthetics is highly subjective. Nevertheless, Wolfart and coworkers used a visual analogue scale (VAS) to extrapolate their results; inevitably therefore, they might have read too much into their data.²⁰ The above-mentioned reasons might account for the differences

between our results. Moreover, the range of variations they used was wider than the range used in this study.

On the other hand, the 52% lateral-to-central width proportion was the 'least favoured' by 46.3% of hypodontia patients, 39.5% of control participants and 80% of dentists. Results showed that both hypodontia and normal patients were not as decisive as dentists ($p = 0.02$ and 0.002, respectively). Other proportions that are considered as 'least attractive' by minor groups might account for the differences between dentists and the other groups. These results are in tandem with the results from Kokich *et al.* who showed that very narrow lateral incisors were perceived as 'least attractive'.²³ A perceived width dimension 3 mm narrower than ideal incisor crown width was required before it was rated as significantly less attractive by orthodontists and general dentists. On the other hand, lay people required a 4 mm reduction in width dimension before they significantly rated it as least attractive. Possible reasons why narrow lateral incisors are less well tolerated include: (a) the smile appears less broad; (b) the pointed canines are situated more mesially and are more visible; and (c) overall there is less tooth show, giving the dentition a less white appearance (as pointed out by one patient in our study).

Collectively, however, we conclude that the attractive lateral-to-central width proportion is not a single proportion but rather a range. All groups tend to prefer the wider lateral incisor to the narrower ones. Most assessors, particularly dentists, are less tolerant to very narrow maxillary lateral incisors. There was no difference in perception of 'most or least attractive' width arrangement between the hypodontia and the normal control patients.

Following changes in the length of the maxillary lateral incisor, results showed that an anterior dental arrangement with the maxillary lateral incisors 1.5 mm shorter than the adjacent central incisor was the 'most popular'. These results are in agreement with the long-established standard guidelines for setting anterior teeth for complete dentures. A 1-1.5 mm shorter lateral incisor was always thought to contribute to the natural look of the dental arrangement.²⁴

However, results suggest that hypodontia patients might have a preference for longer lateral incisor arrangements ($p = 0.001$). Brisman showed that patients preferred an arrangement with anterior teeth that are almost at the same horizontal plane.²⁵ On the other hand, dentists preferred a greater amount of radiating symmetry with the incisal edge of the lateral incisor off the plane of the adjacent central incisor.²⁵ Conclusions from this study were based upon diagrammatic sketches and not real three-dimensional smiles or tooth arrangements, which is a major limitation. Similarly, because the reliability of the hypodontia group in assessing this particular set of images was less than optimal, this suggestion must be viewed with vigilance.

On the other hand, there was a general agreement that smiles with both the very long lateral incisor setting (0.5 mm shorter than central) and the very short arrangements (2.5 mm shorter than central) were equally perceived as 'least attractive', with no evidence of statistical difference between any of the three groups. Our results did not disagree with what has been originally suggested in the dental texts and literature.

In order to investigate the basis of the participants' preferences, the correlation between their ability to detect changes

in dimension of lateral incisor and their choices was tested.

For obvious reasons, dentists were significantly more able to detect changes to both width and length of maxillary lateral incisor. However, even though some of the participants were not able to detect the changes in width of the lateral incisors, their reliability to arrange the duplicate images was still good. This result is interesting as it suggests that although participants could not detect exact modifications, intuition may have played a role in the selection process.

On the contrary, ability to detect the changes significantly affected the choice of the 'least attractive smile'. Since 52% width proportion was generally the 'least attractive' proportion, this might give an indication that participants were more perceptive to narrowness of the maxillary lateral incisor. Moreover, there was a direct correlation between the ability to detect changes in length of maxillary lateral incisors and perception of both 'most and least attractive' smiles ($p = 0.003$ and 0.0001, respectively). This might give an indication that people are more sensitive to changes in length than they are to width.

Effect of gender was also investigated. Generally, there was no difference in preference of a particular aesthetic feature between males and females. However, males of the normal 'control' group were more reliable than their female counterparts. This might be an effect of age distribution, which was unequal throughout the groups, or an effect of complex interaction between sex of the evaluator and sex of the material to be tested.

Results of this study suggest that, generally, there were no differences between the perception of normal and hypodontia patients. However, hypodontia patients showed special affection for longer maxillary lateral incisors. Additionally, although we are able to show that other proportions attained greater popularity than the originally suggested golden proportion, we cannot totally disregard the perception of the minor group. Therefore, we suggest that an additional diagnostic step is of paramount importance. This step will lay emphasis on the importance of considering the patients' appreciation and understanding of dental aesthetics when formulating a treatment plan. What we, dentists, consider as pleasing does not necessarily appeal to our patients. The introduction of a computer-aided treatment plan to present various modifications to the patient, before deciding on the final treatment, might be a future need.

CONCLUSIONS

Within the limitations of our study, we are able to draw the following conclusions:

- The golden proportion is not a single value but rather a 'range'
- The 67% lateral-to-central width proportion is most preferred by all groups, followed by the 72% width proportion
- The general population is less tolerant to reductions in maxillary lateral incisor width. The 52% is least preferred by all groups
- There is a general inclination to prefer the wider lateral incisor over the narrower ones
- The overall perception of the length of the maxillary lateral incisor is in agreement with the long-established 1-1.5 mm shorter lateral incisor that was thought to contribute to the

natural look of the dental arrangement. However, hypodontia patients showed a preference for longer lateral incisors compared to the other groups

- The very short and very long maxillary lateral incisors were consistently perceived as 'least attractive'
- There was no difference in preference of a particular aesthetic feature between males and females.

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