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Registration: Stage III — selection of teeth

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In this section, particular attention is drawn to guidelines on the selection of teeth for complete dentures. Factors influencing selection of teeth are discussed and presented in tabular form for easy guidance.

In this part, we will discuss:
- How to select appropriate moulds of anterior teeth
- How to select appropriate moulds of posterior teeth
- Factors influencing shade of teeth

As has been mentioned in Part 1, in the United Kingdom the dental surgeon is the sole agent licensed to prescribe and co-ordinate the functional and aesthetic requirements for each patient's replacement teeth. In the decision-making required for the selection of replacement (denture) teeth for edentulous patients, the dental surgeon should show a knowledge of physiological and biological factors pertinent to each patient. These factors should be co-ordinated with aesthetic factors applicable to each patient, taking notice of patient perceptions of appearance.

Dental literature is replete with anecdotal references to aesthetic aspects of complete denture construction but this is an imprecise area, combining 'scientific' and 'artistic' principles. The 'scientific' principles are based on reasonably limited longitudinal studies that, ultimately, may not necessarily cater for the needs of each individual patient, while the 'artistic' component is a paradigm of clinician's skill, technician flair and patient acceptance. The integration of these principles has led to a variety of guidelines to help the dental surgeon in the selection of (replacement) denture teeth. Unfortunately, on the evidence of prescriptions sent to dental laboratories, it is clear that these well-intended guidelines are often cast aside.[1,2] It would seem, in general terms, that many clinicians fail to record any selection of tooth mould and/or shade and thereby abdicate the responsibility of selection of the shades and moulds to the dental technician. Equally, most clinicians spend perhaps one or two minutes over the selection of shades for six anterior fixed restorations but a fraction of that time for complete denture teeth. Such lack of any consideration of the body image of the edentulous individual mirrors the status of complete denture prosthodontics in dentistry; for the sake of the edentulous population, and our profession, this must not be allowed to continue.

The purpose of this section is to simplify the task of selection of teeth by dividing the process into four separate stages:

- Selection of upper anterior teeth
- Selection of lower anterior teeth
- Selection of posterior teeth types and moulds
- Selection of shade(s) of the anterior and posterior teeth.

Selection of upper anterior teeth

Using pre-extraction records

If patients have pre-extraction records (eg photographs or casts) then the surgeon's task is simplified, although the clinician should always temper photographic evidence to accommodate for biologically/chronologically-induced age-changes. For example, the amount of central incisor tooth showing with the upper lip at rest in a 25-year-old tends to be considerably greater than that of a person in late middle age or older. Equally, the clinician should take into account other dental-related changes such as physiological wear of teeth and facial changes evident from the photograph (Fig. 1). Photographic features and/or peculiarities of lower anterior teeth and posterior teeth may also be determined. For this a good, clear photograph is required.

The use of photographs is to be strongly recommended. Particularly useful are those of a

Fig. 1 Two photographs to show subtle facial and dental changes which can occur from late youth to middle age

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REFEREED PAPER

2000; **188:** 660–666

patient that were taken when the subjects was dentate or wore dentures which were admired by the patient. The photographs should realistically show head-on facial views of the patient smiling; failure to do this may not reveal any sign of the anterior teeth. Such views should enable the clinician to see and to measure carefully the ratio of the patient's horizontal intercanine distance, and relate that to the interpupillary distance in the photograph. In the clinic, the clinician may then measure the patient's interpupillary distance and it should be possible to establish the horizontal width of the upper six anterior teeth (Fig. 2).

Other guidelines to the selection of replacement upper anterior teeth are itemised in Table 1.

In most cases, however, no adequate photographs or other pre-extraction records are available and the clinician has to decide how best to select the teeth that will satisfy aesthetic and functional parameters. It is at this stage that guidelines relating to anterior tooth positioning may be used and these guidelines are centred on the fact that the (six) upper anterior teeth should:

- Appropriately support the upper lip
- Occupy that area of the upper anterior arch bordered by the corners of the mouth
- Allow for individualisation where indicated, eg rotation, imbrication or spacing.

It should be stressed that the patient may well be entirely satisfied with the teeth on their present (or perhaps an earlier favoured) denture and there is much sense in repeating the prescription of existing moulds.

We would argue that to achieve this, the clinician should select the teeth on the basis of measurements and decisions made with the upper rim still in place, in order that functional and aesthetic parameters may be assessed (*see* Part 5).

With the upper rim in place and the lip appropriately supported (*see* Fig. 8, Part 5) and the incisal point determined, the patient should be asked to smile. By marking the outline of the high smile line on the upper rim, the clinician is assisting the decision making for tooth moulds (Fig. 3). Another critical point is to determine the position of the canine teeth. Earlier reference has been made to the use of pre-extraction records. Where these are not present, some authorities advocate using the position of the corners of the mouth, at rest. Another method, used by the authors, is to ask the patient to smile and to extend a line from

Fig. 2 (below) Template to assist in formulating the (horizontal) width of the upper six anterior teeth

Fig. 2 **Formula for calculating horizontal width**

$$\frac{\text{Width of upper six anterior teeth (photograph)}}{\text{Interpupillary width (photograph)}} = \frac{\text{Width of upper six anterior teeth}}{\text{Interpupillary width (actual)}}$$

Table 1 **Guidelines to the selection and position of upper anterior teeth* indicates that photographs of appropriate quality are used**

Nature of guideline	Frontal view	Sagittal view	Coronal view	Other
Pre-extraction	Photograph *Relate canine points to pupils *Relate canine points to inter-alar width (smiling) *Relate six anterior teeth to smile line Cast of arch Radiograph Relative of similar facial appearance	Photograph Cast of arch *Relate six anterior teeth to smile line Cast of arch Radiograph Relative with similar appearance	Photograph (unlikely) Radiograph (unlikely) Relative with similar appearance	Extracted teeth
Post-extraction	Central incisors restore philtrum if possible Central incisors restore vermillion border Incisal points and smile line determine height of tooth (age-related) Position of canine points Relate to inter-alar width (smiling) Relate to pupils (require pre-extraction photograph) Relation of upper rim to smile line	Vertical naso-labial angle Amount of tooth showing below lip at rest (age-related) Relation of upper rim to smile line		

Fig. 3 The scribing of the high smile line on the ACB helps the clinician to determine the height of the central incisor tooth. Care should be taken to compensate for tooth wear

Fig. 4 Dental floss used to give an acceptable guideline for the position of the canine tip on the ACB

the inner canthus of the eye via the lateral border of the alar cartilage and extend that onto the upper rim. This may be done with a ruler or by the use of dental floss (Fig. 4). This equates, in a high proportion of cases, to the position of the tip of the upper canine teeth.[3] If a flexible ruler was laid from one canine point to another on the upper rim (aesthetic control base [ACB]), the length of the 'aesthetic anterior arc' could be read off; this reading is the second critical dimension required to prescribe tooth moulds (Fig. 5). Prior to scrutinising mould charts, however, it is of critical importance that the clinician determines how the patient desires the tooth arrangement to look. If the patient wishes spacing, then clearly that would require teeth of a smaller width to be used. The converse is true where imbrication or crowding is desired. The importance of the two measurements is apparent when one examines most tooth mould charts. Figure 6 illustrates typical measurements associated with all anterior teeth, although in the interests of fairness, fictitious mould names have been incorporated to avoid apparent favouring of any one mould. It can be seen that there are three values allocated per mould:

1. The combined widths of all six anterior teeth, ie from distal of canine to distal of the contralateral canine (in mm). NB This is approximately the circumference of the upper rim from one canine point to the other plus 8–10 mm.
2. The height of the central incisors from the incisal edge to the highest point on the labial face of the tooth corresponding to the highest point of the crown (in mm).
3. The width of the central incisors.

While the third value is of use in the prescription of removable partial dentures, we do not see any obvious value in the determination of tooth moulds for replacement complete dentures other than ensuring that replicated moulds are copied faithfully.

Armed with these two measurements, which may be read off the record rim, the clinician should be able to select from those moulds that lie within 1 mm of the selected intercanine distance. Similarly, an awareness of dental ageing changes is required when the height of the central incisors is being considered. The distance measured from the record rim is from the incisal tip to the high smile line. Most prosthodontic textbooks recommend that the highest point on the labial aspect of the crown lies 1 mm above this; clearly for middle-aged and older patients, modification of the central incisors will be required (ie remove the translucent tip of the incisal edge) to reflect the age of the patient (Fig. 7). In order to customise the anterior teeth to reflect the age of the patient, the clinician will usually select longer central incisors than would be expected, to permit incisal grinding. On the other hand, some patients may not show much of their teeth when they smile. This may be a cultivated habit, for socio-psychological reasons, a consequence of tooth wear and a long upper lip, or perhaps simply a feature peculiar to these patients. This may be clear from a good photograph of the patient smiling. It may also be

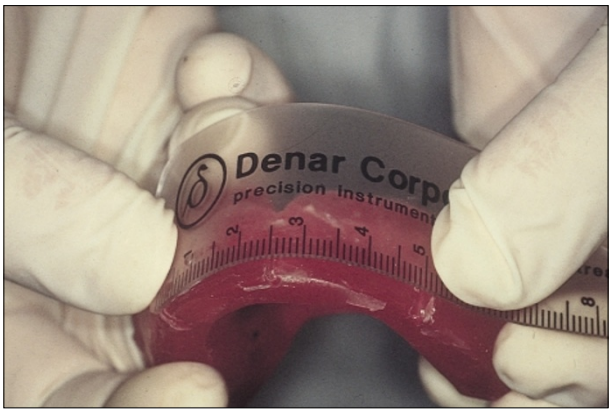

Fig. 5 Flexible ruler used to measure the (labial) circumference of the arc from one canine tip to the other. As tooth mould charts for anterior teeth give dimensions from the distal of one canine to the other, 8–10 mm should be added to the above measurement, to cater for the distal 'half' of each canine

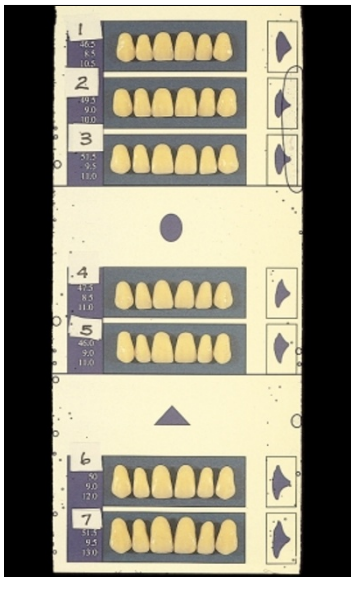

Fig. 6 Tooth mould chart indicating dimensions of several moulds

apparent at the time of preparation of the upper rim (ACB).

The clinician is, at all times, advised to consult with the patient regarding the patient's wishes and expectations on tooth selection, to avoid, or at worst to minimise, any potential problems of acceptance of the replacement denture at a later date.

Clinical experience, however, indicates that even when these two measurements are followed, other factors are brought into play to finalise anterior tooth selection. Williams, in 1907, suggested that the frontal appearance of the face from the (normal) hairline to the chin could be used as a guideline to the inverse shape of the central incisor (Fig. 8).[4] Some tooth manufacturers, in an attempt to assist clinicians to select appropriate tooth moulds, suggest that the labial shape of the anterior tooth reflects the shape of the (edentulous) maxillary arch. Neither of these has any scientific credence, indeed the latter takes no account of trauma or unusual post-extraction changes.

We recommend that clinicians should assess the facial profile in a three-dimensional way. This involves incorporating frontal and lateral views plus that taken from behind the patient looking down the face, to determine an overall view of the dento-facial profile. Patients from each of the skeletal classifications may be identified and this can help the clinician select a tooth mould which is in accordance with the profile of the appropriately supported lip (Fig. 9) on the basis of clinical experience of facial forms.

Selection of lower anterior teeth

As has already been referred to, pre-extraction records may be used to ensure appropriate tooth selection and, indeed, the anterior form of the trial dentures.

When these are not available, referral may be made to manufacturers' mould charts to equate the lower anterior teeth to the selected upper anterior teeth. Or the practitioner may opt to create a functionally-generated profile of the lower denture space[5] (sometimes called the neutral-zone impression technique), identify the position of the lower canines (via the angle of the mouth) and then measure the canine-canine distance. As tooth moulds for lower anterior teeth have the equivalent three measurements to upper anterior teeth, the clinician may choose for the mould that is appropriate for each patient, taking age, facial form and patient perceptions into account.

Selection of posterior teeth types and moulds

It is probably accurate to state that this portion of the prescription form is least considered by clinicians, the choice of posteriors being often made by technicians who tend not to have seen the patient. This is a remarkable state of affairs when one considers that complete dentures are supposedly prescribed primarily to restore function and secondarily to restore facial appearance.

As this series is intended for interested general dental practitioners and not for specialists, there will be no section on the geometry of occlusion, as that will be covered in standard prosthodontic textbooks. It is pertinent, however, to discuss, albeit briefly, types of posterior teeth.

According to Lang posterior tooth moulds are of four types:[6]

1. Anatomic
2. Non-anatomic
3. Zero-degree teeth
4. Cuspless teeth.

According to the Glossary of Prosthodontic Terms, the following definitions apply to each type:[7]

Fig. 7 Photograph of unprepared upper right central incisor from a mould (A). The modified tooth (B) has been adjusted to suit the patient by grinding away the incisal translucency. The clinician should compensate for this in selecting the mould

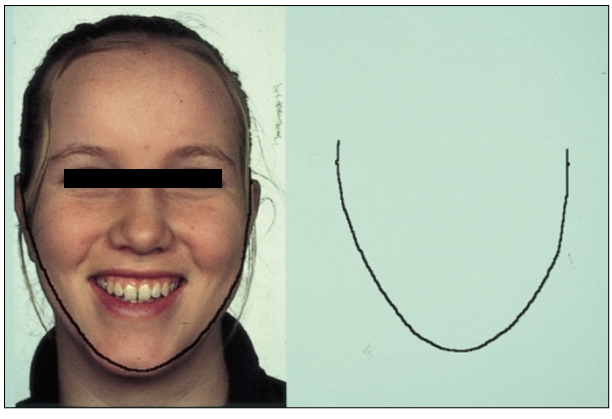

Fig. 8 Williams' guideline to tooth selection by relating upper central incisor form to frontal appearance of the face has no scientific credence

Fig. 9 With a well-formed upper rim (ACB) *in situ*, the clinician can interpret a skeletal form which may suggest an appropriate incisor arrangement. In this case, with the ACB, the v-shaped form of the maxilla is clear to see, suggestion of a Class II division I appearance

1. Anatomic: teeth that have cuspal inclinations greater than 0° and tend to replicate occlusal anatomy. Such teeth may have cuspal angles set to 20°, 30°, 33° or 45°.
2. Non-anatomic: teeth designed in accordance with mechanical principles rather than from the anatomic standpoint.
3. Zero-degree teeth: posterior teeth that have 0° cuspal angles.
4. Cuspless teeth: teeth designed without cuspal prominence on the occlusal surface ie inverted cusp teeth.

Fig. 10 a) Posterior teeth which have cusps b) Posterior teeth which are cuspless c) Hybrid mould ie teeth which are modified to obtain the benefits of a) and b)

We would suggest, in the interests of clarity, that three types of posterior tooth form be considered, namely teeth with cusps, teeth without cusps and teeth which exhibit both characteristics (hybrid moulds). Such teeth typically have upper teeth with cuspal angles of 20° with modified buccal cusps and lower non-anatomic teeth which have been rendered essentially cuspless (Fig. 10a–c).

The decision the clinician has to make should be determined out of the needs of the patient. In essence, three factors have to be considered, namely occlusal factors, stability factors and aesthetic factors (Table 2).

Occlusal factors

If the patient only performs vertical mandibular movements then it is possible that cuspless teeth will suffice. If, however, the patient performs ruminatory mandibular movements (watch the patient eat a biscuit or a piece of carrot), then teeth with cusps will be required for balanced articulation (and thus stable dentures). Examination of current dentures may assist in the diagnosis (Fig. 11). For example, if

Table 2 List of factors influencing selection of posterior tooth form

Type of Tooth	Occlusal factors	Stability factors	Aesthetic factors
Teeth with cusps	*Balanced occlusion* Possible, but may require grinding to prevent slide from RCP to ICP *Balanced articulation* Cusps are required to obtain a truly balanced occlusion, but technician's skills and time are implicit, as is sound registration technique	If no slide present, stability possible Can be problematic with flat lower ridges and in implant-borne cases	Tend to look better as they appear natural, as long as teeth of appropriate length are selected
Teeth without cusps	*Balanced occlusion* Possible and these teeth generally take less laboratory time to set up *Balanced articulation* A truly balanced articulation is not possible with these teeth	Absence of cusps in the upper posterior teeth means balanced articulation is not possible	Have a worn (attrited) appearance
Hybrid teeth	*Balanced occlusion* Possible some grinding may be necessary *Balanced articulation* Possible if concepts such as lingualised occlusion are used, ie the maxillary palatal cusps are intended to maintain contact with their antagonists	The presence of cusps, even modified cusps, can facilitate balanced articulation with reduced chance of cuspal locking	Can look natural

the dentures have occlusal surfaces that are evenly worn (ie flat), this is usually suggestive of vertical (chopping) mandibular movements, whereas much greater wear of the maxillary buccal cusps especially, is suggestive of ruminatory mandibular movements.

Stability factors

In addition to stability engendered out of muscle balance and occlusal balance in all border positions, cusps that tend to lock or cause tripping can aggravate the stability of dentures. This is particularly pronounced in flat, atrophic mandibular ridges. Some schools of thought automatically prescribe cuspless teeth in such cases; clearly if balanced articulation is required, cuspless teeth are, in such cases, illogical. Another factor to consider is the width of the posterior teeth. If the posterior teeth are too broad, they could present to the tongue what amounts to lingual undercuts and the presence of these could lead to a major cause of instability (Fig. 12).

Thought should also be given to the number of posterior teeth. There are few clinical situations where there is sufficient mesio-distal length to incorporate two molars and two premolars without compromising stability (*see* Part 10 on diagnosis of faults); common options are to drop off either one premolar or one molar.

Aesthetic factors

These factors are ones that can only be determined by the patient and are a good example of the value of informed consent; the patient should be informed of the options and allowed to decide on the appearance of posterior teeth as well as anterior teeth.

Selection of colour and shade of teeth

As this book is intended to serve as a clinical aid for general dental practitioners, no attempt will be made to detail the fundamentals of the colour scheme.

While great care is often spent by dental practitioners over the selection of teeth of appropriate colours and shades, eg six anterior crowns, conventional wisdom would suggest that this is not the case where the selection of teeth for complete dentures is concerned.

Nevertheless, practitioners should take into account four qualities when selecting denture teeth.

1. *Hue:* This is a specific colour resulting from light of a particular wavelength acting on the retina. The hue is an indication of a specific colour, eg blue, green, reddish yellow. Some authorities suggest that the hue of teeth should harmonise with the hue of the patient's face/natural hair. Others, however, quote studies that cast doubt on this philosophy.[8]
2. *Saturation (chroma):* This represents the amount of colour per unit area, eg a tooth may appear greyer than another tooth. The hue of both teeth could be equal or one tooth could contain a higher saturation of the grey than the other.
3. *Brilliance (value):* This equates to the lightness or darkness of a tooth. Variations in brilliance are affected by dilution of the colour (ie the hue) by black or white. It is the ratio of white or black on teeth to the natural hue which determines the lightness or darkness of teeth.
4. *Translucency:* This property enables light to pass through a body without giving any distinguishing image.

The careful selection of colours and shades of teeth is therefore verging on the artistic interpretation of the clinician and the patient. The patient may have very strong views on the shade of their replacement dentures and it may be a clinical advantage to have two options available in shade guides. One is the standard shade guide which is calibrated in shades A, B, C and D. The second option is ranged from the lightest

Fig. 11 This patient clearly undertakes a range of border movements and should be provided with balanced articulation

Fig. 12 The occlusal tables on this lower denture are too large. First of all, the excessive width of the molars is presenting lingual undercuts which will de-stabilise the denture. In addition, the presence of the second molar on the inclined plane of the ramus will induce a protrusive movement

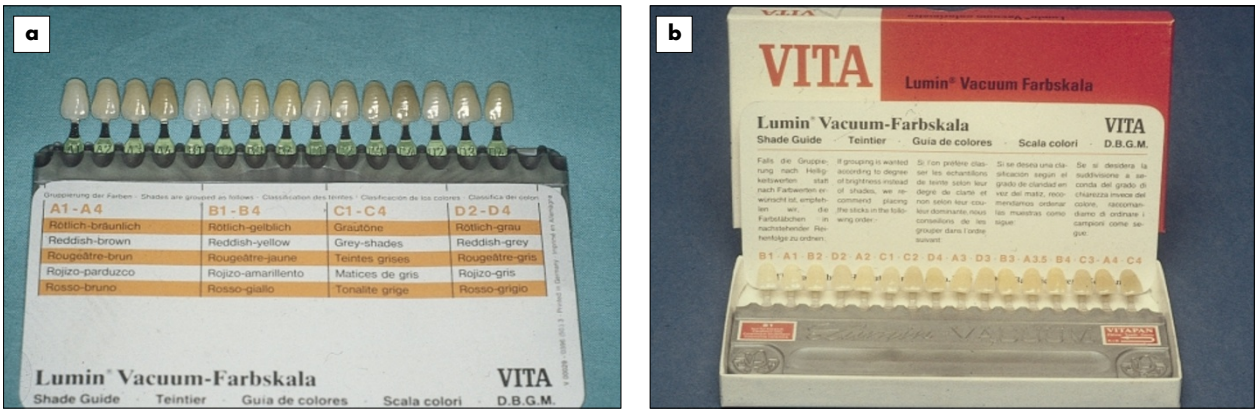

Fig. 13 Vita shade guide: a) arranged according to colour; b) according to lightness

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shade C to the darkest shade (Fig. 13a and b). We would emphasise a careful and deliberate consultation with patients regarding shades of teeth, taking into account age (teeth tend to become darker with age although this is not always absolute), patient preference and, with guarded reservation, skin colour. The selection may also be varied, eg there is often justification in having canine teeth slightly darker than incisors (Fig. 14).

When all of these details have been recorded on the laboratory (prescription) card, the rims may be dispatched to the laboratory for final dentures to be made.

Helpful Hints

1 Listen to the patient's views.
2 Use photographs/favoured dentures if possible.
3 Use the aesthetic central base to assist in the delineation of the maxillary 'anterior aesthetic arc'.
4 Select lower anterior teeth to complement the upper anteriors.
5 Select posterior teeth using aesthetic and functional criteria.

Fig. 14 View of natural incisors. Note there is no real harmony between the hue of the face and that of the teeth. The canines, however, are darker than the incisors