

IN BRIEF

- This study looked at 96 patients whose facial aesthetics had been improved by increasing the vertical dimension of occlusion.
- To substantiate the subjective view of the patients, an independent panel also looked at the patients' pictures.
- According to the views of the patients and the panel, nearly 80% of patients were thought to look 5 to 20 years younger. The improvement related to the whole range of facial features (eyes, nose, cheeks, lips and skin) not just the lower face.
- This treatment is non-surgical, and gives the natural improvement which some patients prefer to cosmetic surgery.
- This improvement in facial aesthetics is a truly anti-ageing process and opens new avenues for further research.

The effect of increasing vertical dimension of occlusion on facial aesthetics

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Aim To investigate the effect of increasing the vertical dimension of occlusion on facial aesthetics.

Setting General practice.

Method Questionnaires were sent to 96 patients who had been treated in the practice during the period of July 1998 to December 2000, resulting in an overall 72% response rate. All these patients had had their occlusal vertical dimension increased. Photographs of patients were taken before, during and after treatment. The questionnaire asked their opinion on the effects of the treatment on their facial features. To obtain an objective view to substantiate the opinions of the patients, a panel of five judges reviewed the before and after photographs and filled in their own questionnaires.

Results Of the patients who responded to the questionnaire, 79.7% said they looked younger after the treatment. The panel thought 81.2% of the patients treated whose photographs they reviewed looked younger.

Conclusion Increasing the vertical dimension of occlusion can have far reaching effects on facial aesthetics, not just on the peri-oral areas but on the whole face.

Facial ageing is a biological phenomenon. Ageing is an inevitable fact of life – from the time we are born our genes lead our body through a series of changes ranging from growth and development to maturation, ageing and finally death. This process appears to be not only programmed genetically but also influenced by lifestyle and environment.¹ Our obsession with attractiveness and youthfulness is partly related to this ageing process. The effects of ageing on the face are well documented.² These effects are basically due to changes in the facial skin,³ the facial muscles and the bony infrastructure.⁴

In the dentate patient the facial ageing is believed to be totally due to soft tissue changes.⁵ Ageing of the skin is associated with progressive atrophy of the dermis as well as changes

in the dermal tissues. This leads to thinning, wrinkling, sagging and laxity of the facial skin. On the forehead this results in horizontal and vertical wrinkles and sagging of the eyebrows. Around the eyes there is bulging of the skin above the upper eyelid and also below the lower eyelid. The corners of the eyes droop. The skin at the corner of the eyes shows 'crows feet'. The cheeks flatten with age. The appearance of naso-labial folds and flattening of the cheeks could be due to gravity assisted sagging of the soft tissues and perhaps to relative maxillary retrusion.⁶ Ageing causes an increase in the vertical length of the nose, decreased tip projection and a tip droop. In the perioral area, naso-labial folds develop, fine vertical rhytids appear, and lips appear thin with loss of exposed vermillion. There is diminished tooth display of the maxillary anterior teeth and increased display of mandibular anterior teeth.⁷ Corners of the lips tend to droop downwards and join up with the marionette folds. The jaw line appears irregular due to the presence of jowls. The chin also tends to droop and the neck shows platysma banding and horizontal wrinkling.

The muscles of the face show a significant reduction in cross-sectional area and density with age.⁸ The cross-sectional area of facial muscles in edentulous subjects shows a greater decrease than their dentate counterparts. However, the decrease in density does not seem to be related to the absence of teeth. Human jaw muscles also undergo region specific changes in fibre composition during ageing.⁹

As stated before, facial ageing is believed to be due to soft tissue changes in the dentate patient. However, there is some evidence to show that bony changes can affect the facial mask and lead to the formation of naso-labial folds. In the edentulous patient, loss of alveolar bone eventually leads to a reduction in the resting vertical dimension.¹⁰ This loss of facial height leads to diminished facial contour and leads to the typical 'witches profile'. Facial height has a profound effect on attractiveness. Occlusal vertical dimension (OVD) determines facial proportions at maximum intercuspation and influences facial dimension at rest. Underdevelopment of alveolar bone may result in loss of lower facial height and could lead to signs of premature ageing.

The loss of muscle mass and compactness leads to reduced mechanical strain on the facial bony structure and could be one of the main factors contributing to maxillary and mandibular bone loss.

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METHOD

Questionnaires were sent to patients whose vertical dimension had been increased to obtain their subjective opinion as to whether they thought an improvement in facial aesthetics had been achieved by this treatment.¹¹

The increase in vertical height was achieved by using the principle of mandibular position in swallowing. After a thorough examination of the mouth and the articulatory system, acrylic pivots were provided at this height either on a training plate or on their existing mandibular denture.¹² The height of the pivots was modified, taking into account the golden proportion rule for facial aesthetics.¹³ The smile window was used to obtain the most aesthetic occlusal plane.¹⁴ Often the vertical position chosen looked as if it was wrong, especially as indicated by the contraction of the mentalis muscle. This was not taken to be a contraindication.¹⁵ Given time these muscles relaxed. The centric relation and occlusion were obtained with the patient standing upright, and then gently tapping the teeth together without straining the jaw. It was important to ensure that the jaw was not in a retruded position or pushed forward into a class three position. This should give the position of the mandible relative to the maxilla with the articular disc in place, when the muscles that support the mandible were at their most relaxed and least strained position.

The age of the patients treated varied from 36–84. Patients treated were predominantly female (88.5%).

All the patients had been treated in general practice during the period August 1998 to January 2001. The questionnaire was sent to 53 patients in July 2000. In January 2001 questionnaires were sent to a further 43 patients. The questionnaires sent to the patients emphasised the fact that they were being surveyed anonymously. The questionnaires were sent to all patients who had been treated as part of a continuous evaluation to judge the success of this technique. The two groups were purely divided by time factor. Patients whose lower facial height had been increased are usually treated at stage one with temporary restorations and at stage two, six months later with their final permanent restorations. At this stage their facial width is increased, if needed, by increasing the maxillary arch size and/or the sulcus width in the edentulous patients. However some patients are happy with their stage one treatment and do not progress on to the second stage of the treatment. Second stage treatment does modify facial aesthetics to some degree but not as dramatically as the initial increase in vertical dimension of stage one. Questionnaires were not sent to any patients who were in the middle of having stage one or stage two treatment. The patients were asked the following questions:

Do you think the treatment has made you look years younger?
(Yes/No)

If yes, please select a figure from the following:
5 yrs 10 yrs 15 yrs 20 yrs

Which of your features would you say have improved with the treatment? (Please circle all that apply)
None Lips Jaw Line Eyes Chin Skin

Patients treated up to August 1999 had photographs taken with a 35 mm single lens reflex camera and were shown their photographs on their subsequent visit to the practice. From August 1999, digital photography was used, eliminating the delay and also enabling patients to examine their features in greater detail because of the flexible zoom facilities offered by digital photography. All photographs were taken with the patient's teeth in maximum intercuspation.

Since there was a strong possibility that the subjective opinions of the patients could be biased, it was decided to show 'before' and 'after' photographs of the last 52 patients treated to a panel consisting of an artist, a dentist, a dermatologist, a journalist who worked for a health and beauty magazine and a patient who had already had the treatment. The panel was in the age range 26–69 and consisted of two males and three females.

The panel were given photographs showing the effect of ageing on the various facial features in addition to the photographs of the patients. This was done so that they could examine the patients' photographs more objectively. The panel were shown four photographs of each patient, before and after profile and before and after full-face view. In all, they had to look at 208 photographs. The panel were then asked to fill in the same questionnaire as given to the patients.

RESULTS

A questionnaire was sent to 53 patients in August 2000 and 37 of these replied to the questionnaire (70%). In January 2001 the questionnaire was sent to a further 43 patients and 32 (74%) replied. Reminders were subsequently sent with self-addressed envelopes, in order to obtain as high a response as possible. The questionnaire was kept as brief as possible for the same reason. The overall response rate to both questionnaires was 71.9% (69 ex 96). All but one of the patients who responded had noticed an improvement to their facial features, and 79.7% thought the treatment had made them look much younger. This compared with the panel result of 81.5% (Figure 1).

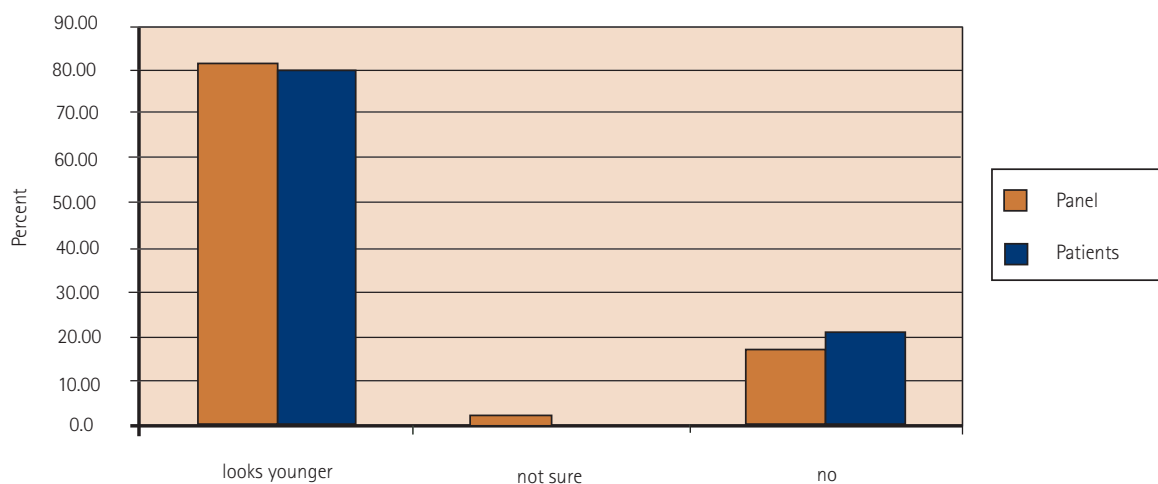


Figure 1. Patient and panel response

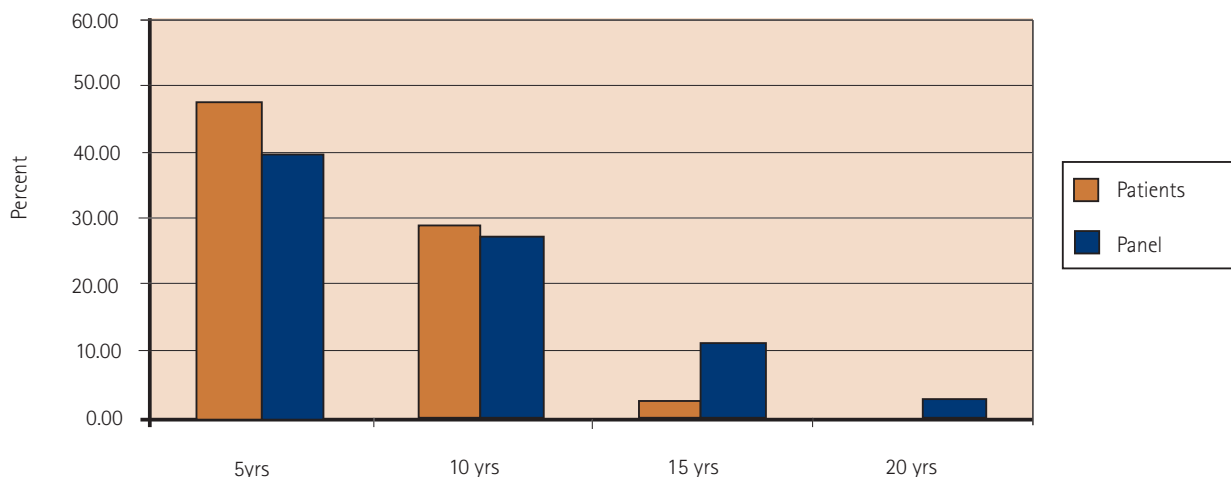


Figure 2. How many years younger do they look?

The response to the question as to how many years younger they looked was predictably modest from the patients themselves but much more generous from the panel. A total of 62.5% of the patients thought they looked 5 years younger, 21.9% thought they looked 10 years younger and 2.7% thought they looked 15 years younger. The panel thought 39.2% of the patients looked 5 years younger, 27.3% looked 10 years younger, 11.5% looked 15 years younger and 2.9% looked 20 years younger (Figure 2).

The response to the question: 'Which features of the face do you think have improved by the treatment?' drew very similar responses from both patients and the panel. Twenty five percent of the patients thought their noses had improved, 90.6% thought their lips had improved, 87.5% thought their jaw line had improved, 28.1% thought their eyes had improved, 62.5% thought their chin had improved and 28.1% thought their skin had improved. The corresponding panel results were 23.5%, 78.1%, 58.5%, 28.1%, 74.2% and 28.1% (Figure 3).

In the first questionnaire, 5.4% noticed an improvement in their noses and in the response to the second questionnaire 25% noticed an improvement in their noses. This second figure closely matches the panel results: 23.4% thought the noses had improved. This also reflects the fact that as the technique has developed, more of the changes to the faces have been observed. At first changes were noticed in the peri-oral area only and gradually changes to all the features of the face were observed (Figure 4).

DISCUSSION

In setting up this investigation there were several problems, including concerns that many patients would not want the fact that they had received the treatment to be publicised. Furthermore, 45% of the edentulous patients had not perhaps had time to fully recover from the trauma of losing their teeth.¹⁶ Many of the patients felt that it was difficult for them to judge how much younger they looked. Some of them emphasised that they did not particularly want to look younger but rather wanted to look good for their age. A fairer question might have been to ask if their facial features had been enhanced and then to grade them on a scale of 1-5. Members of the panel commented that it would have been easier to judge the number of years by which the patient looked younger if a range had been given instead of a definite figure. In some cases, members of the panel could not be sure if the patient looked younger. Some of them went on to comment on improvements on individual features but others did not pursue the questionnaire further. The dermatologist also made the comment that it was very difficult for her to judge the improvement in the skin because of the difference in lighting and film exposure in some of the pictures.

This survey included three groups of patients, two (non-overlapping) patient groups who completed questionnaire one and two, and a third group, (drawn from both the questionnaire groups) whose features were then reviewed by the judges. However the variation in the composition of these groups had no

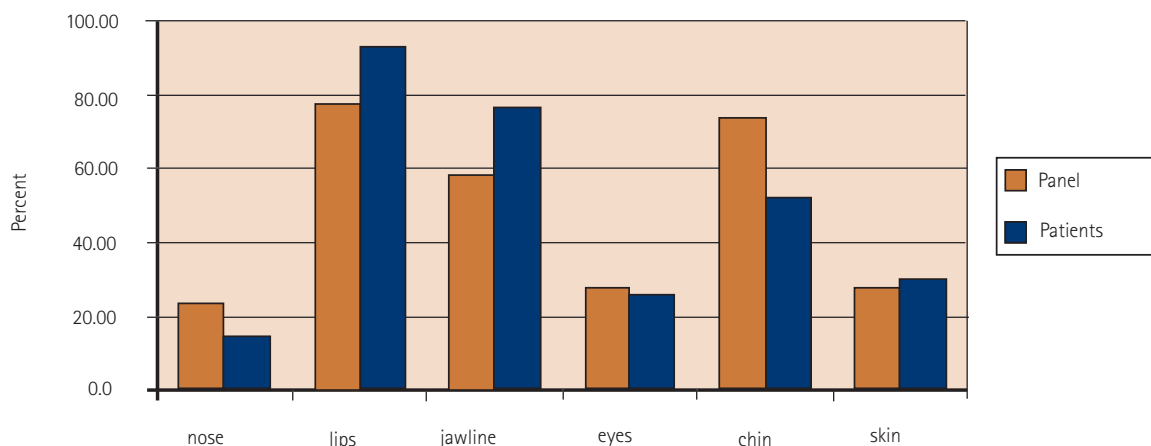


Figure 3. Which features of the face have improved?

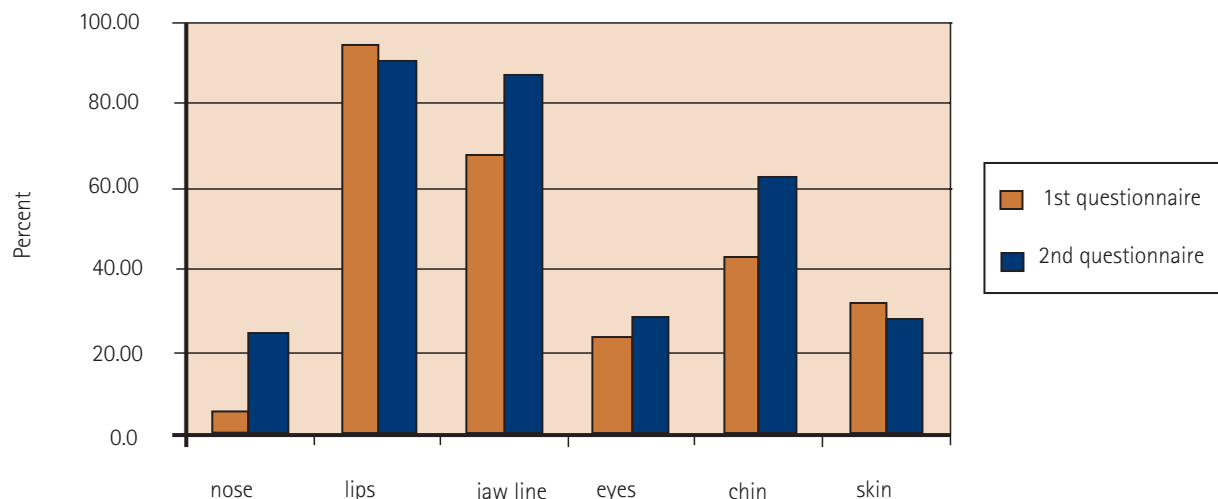


Figure 4. Comparison between 1st and 2nd questionnaire

effect on the overall trend of the results, as indicated by the bar chart comparing panel response and questionnaire responses.

It is clear that increasing the lower facial height enhances the patient's facial features. It was assumed that most of the improvement would take place around the peri-oral tissues – that is an improvement in the vermilion show and in the patient's smile window. It was very interesting to note that the patients' and the panel's response was not confined just to the peri-oral areas.

The mechanisms by which patients' signs of facial ageing are reversed are based on the fact that both muscles and bone respond to mechanical signals. Bone cells depend on muscle activity and muscles in turn respond to stretch. Stretch of the muscle fibres induces increased protein activity and causes muscular hypertrophy and change in muscle fibre composition, which in turn causes increased strain on the bones. This leads to an increase in the bone density due to the activity of the osteocytes, a change in the architecture of the bone and an increase in periosteal thickening. Stretch of the muscle fibres also induces release of mechano-growth-factor (MGF) and insulin growth factor (IGF 1).¹⁷ This increased cellular activity seems to lead to an increased vascularity in the tissues and also prevents apoptosis.

The use of pivots to change lower facial height affects the mechanical advantage of the jaw muscles. The change in chewing pattern induced by the pivots also increases the muscle activity of the facial muscles.

The above factors may help to understand the changes to facial features reported in this paper.

Of the people who replied to the questionnaire, 26.8% had noticed an improvement in their eyes. This usually consists of reduction of the loose skin above the upper eyelid and a reduction of the fatty deposits underneath the lower eyelid. A number of patients commented on the tightening of the soft tissue above the upper eyelid, so that it no longer touched the eyelashes, and found an improvement in applying make-up to the area. The lateral droop at the corner of the eyes also improved and there was an improvement in the lateral rhytids in this region. This results in an improvement in the 'sad' looking eyes of old age. The eyes appear much brighter, bigger and more youthful. The above changes may be due to increased fat metabolism that takes place when the facial muscles are being worked harder. The stretched skin may produce more collagen

with improved elasticity. *In vitro* experiments show that skin fibroblasts do not respond to physiological levels of strain but do produce new collagen when stretched beyond the normal levels of stretch.¹⁸ *In vivo* studies may give different results.

The nose shows an improvement in nose tip droop and a decrease in the width of the base of the nose. Some of these changes could be accounted for by the fact that the restoration of the lower facial height enhances the proportions of the nose in relation to the whole face.

The improvement in the jaw line is related to the improvement in the chin and tightening of the facial skin. It could be that there is a reduction in the amount of the accumulation of subcutaneous fat, which produces jowls or perhaps redistribution of facial fat as muscle hypertrophy changes the fat to muscle ratio.¹⁹ The facial skin improves because of the stretching of the facial mask but there seems to be an improvement in the thickness of the skin itself. This may be due to increased collagen production, improved elasticity and improved blood flow to the skin.

The improvement in the vermilion show is probably due again to a number of factors. Muscle hypertrophy possibly plays a role in the improved vermilion show. Increasing the vertical dimension increases the height of the smile window and reduces the width of the smile, which will also increase vermilion show. The positioning of the anterior teeth and the thickness of the anterior buccal flange, in complete denture patients, will also influence the vermilion show.

The improvement in the cheeks is probably due to improvement in muscle tone and mass but in the long term there may be some remodelling of the bone.²⁰

The panel size employed in this research begs the question of how representative of their groups they were. Howells and Shaw²¹ used a 2% non-dental panel to record similar results to a lay panel of 122 people, and panels of 39, 49, and 79 persons were used by Dunleavy *et al.*²² in assessing the changes brought about by orthognathic surgery. In the present case, the panel results were simply being used to corroborate the subjective results obtained from patients, and it was therefore decided that for this purpose the panel numbers were sufficient.

When the panel were shown the photographs, a number of them commented that the 'after' pictures sometimes showed a change of hairstyle or make-up. One of the reasons for this is that when a patient gains confidence with their new look, they

want to develop an accompanying new image, resulting in experimentation with changes of hairstyle, dress and make up. In future studies it may be advisable to crop the images using computer software to ensure that they are confined to facial features alone.

In conclusion, as people become increasingly concerned about the effects of ageing on their faces, and as surgical corrective procedures become more common, the alternative of having lower facial height increased should perhaps be considered in some cases before embarking on cosmetic surgery. A combination of increase in lower facial height in addition to cosmetic surgery may achieve a more dramatic and pleasing result.

- Johnson F B, Sinclair D A, Guarente L. Molecular Biology of Ageing. *Cell* 1999; **96**: 291-302.
- Gonzalez-Ulloa M, Simonin F, Flores E. *Anatomy of the ageing face: Transactions of the Fifth International Congress of Plastic and Reconstructive Surgery*. 1st Ed. London: Butterworth and Co Ltd, 1981.
- Gilchrist B A. Age associated changes in the skin. *J Am Geriatr Soc* 1982; **30**: 139-143.
- Boyde A, Kingsmill V J. Age changes in bone. *Gerodontology* 1998; **15**: 25-33.
- Bartlett S P, Grossman R, Whitaker L A. Age-related changes of the craniofacial skeleton: an anthropometric and histologic analysis. *Plast Reconstr Surg* 1992; **90**: 592-600.
- Pessa J E, Zadoo V P, Mutimer K L, Haffner C, Yuan C, DeWitt A I, Garza J R. Relative maxillary retrusion as a natural consequence of ageing: combining skeletal and soft tissue changes into an integrated model of midfacial ageing. *Plast Reconstr Surg* 1998. **102**: 205-212.
- Vig R G, Brundo G C. The kinetics of anterior tooth display. *J Prosthet Dent* 1978; **39**: 502-504.
- Newton J P, Yemm R, Abel R W, Menhinick S. Changes in human jaw muscles with age and dental state. *Gerodontology* 1993; **10**: 16-22.
- Monemi M, Kadi F, Liu J X, Thornell L E. Adverse changes in fibre type and myosin heavy chain compositions of human jaw muscle vs. limb muscle during ageing. *Acta Physiol Scand* 1999; **167**: 339-345.
- Ismail Y H, George W A, Sassouni V, Scott R H. Cephalometric study of the changes occurring in the face height following prosthetic treatment. Part 1. Gradual reduction of both occlusal and rest face heights. *J Prosthet Dent* 1968; **19**: 321-330.
- Mohindra N K. A preliminary report on the determination of the vertical dimension of occlusion using the principle of the mandibular position in swallowing. *Br Dent J* 1996; **180**: 344-348.
- Watt D M, Lindsay K N. Occlusal pivot appliances. *Br Dent J* 1972; **132**: 110-112.
- Levin E I. Dental esthetics and the golden proportion. *J Prosthet Dent* 1978; **40**: 244-252.
- Lombardi R E. Complete Dentures. *J Prosthet Dent* 1973; **29**: 358-382.
- Rivera-Morales W C, Goldman B M. Are speech-based techniques for determination of occlusal vertical dimension reliable. *Compend Contin Educ Dent* 1997; **18**: 1214-1223.
- Davis D M, Fiske J, Scott B, Radford D R. The emotional effects of tooth loss: a preliminary quantitative study. *Br Dent J* 2000; **188**: 503-506.
- Goldspink G. Cellular and molecular aspects of muscle growth, adaptation and ageing. *Gerodontology*. 1998; **15**: 35-43.
- Jones D B, Nolte H, Scholubbers J-G, Turner E, Veltel D. Biochemical signal transduction of mechanical strain in osteoblast-like cells. *Biomaterials* 1991; **12**: 101-110.
- Donofrio L M. Fat Distribution: a morphologic study of the ageing face. *Dermatol Surg* 2000; **26**: 1107-1112.
- Enlow D H. *The Human Face*. New York: Harper and Row, 1968.
- Howells D J, Shaw W C. The validity of ratings of dental and facial attractiveness for epidemiologic use. *Am J Orthod* 1985; **88**: 402-408.
- Dunlevy H A, White R P, Profit W R, Turvey T A. Professional and lay judgement of facial aesthetic changes following orthognathic surgery. *Int J Adult Orthodon Orthognath Surg* 1987; **3**: 151-158.