The role of cephalometric radiography and analysis in the treatment planning of dental malocclusions and facial deformities is well established. In isolation their numerical values are meaningless, unless they are compared with a control group or reference population. Generally, reference data published in the literature is used, but this must be viewed with caution as the racial group is frequently Caucasian, and as such is not directly applicable to a patient from the Middle East. To establish cephalometric norms for the Saudi Arabian population, 100 patients with normal Class I dental relationship were examined and measured. The group consisted of 50 males and 50 females, mean age 24.3 and 25.2 years respectively. The results are compared and contrasted with the findings of other Middle Eastern, Caucasian, Negro, Chinese and Japanese studies, and the need to increase the cephalometric database of Middle Eastern populations emphasized.

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Literature Review

Skull radiographs have been used for a variety of purposes from the early days of radiography, but it was not until Broadbent developed a standardized system to take them, that the films could be of use to the orthodontist and oral maxillofacial surgeon. It soon became clear that the cephalometric film could form a sound scientific basis to evaluate dentofacial proportions and discrepancies, and also to provide an anatomical classification for malocclusion and facial form.

The cephalometric radiograph is taken with the head of the patient held in a cephalostat. The head is steadied by the placement of ear rods in the external auditory meatuses, which are then gently tightened, whilst the patient focuses on a fixed point or looks into a mirror on the adjacent wall to keep the head in a horizontal plane. A pointer may also be used which is aligned with the lower border of the orbit, to ensure that the Frankfort plane is horizontal. The head is held so that the midsagittal plane is a fixed distance from the X-ray source, usually 1.5 m (5 ft) and from the cassette containing the film.

The measurement and analysis of the cephalometric radiograph may be taken directly from the film by computer linked digitization, or more frequently from a tracing of the film which allows the identification of selected points and planes of reference. The required measurements can then be taken directly from the tracing.

A cephalometric analysis may be undertaken for several reasons. Firstly, it can form the basis of a classification of the skeletal and dentoalveolar proportions and malrelationships. This can provide information on factors that contribute to the malocclusion or facial deformity and allow an evaluation of the necessary dental or skeletal movements to produce a stable result. Secondly, the analysis can be used to monitor the changes that have taken place as a result of orthodontics or surgery. Serial radiographs and their tracings can be superimposed upon stable structures within the skeleton and can also be used to study the changes that have occurred during the treatment. Finally, cephalometrics can be used to predict growth changes, which can be extremely important in certain craniofacial anomalies. Some authors claim the ability not only to be able to predict the direction of future dentofacial growth, but also the increments to be expected over a defined time period.

In isolation the values obtained from a cephalometric analysis are not very informative. In order to determine their usefulness and as to whether the figures lie within normal ranges, it is necessary to have comparative data regarding average values and variability of a similar population group. Such figures are most commonly taken from the literature and are based mainly on the results of Caucasian studies. These comparative values are derived from a number of groups of individuals with normal facial appearance and dental features. Limitations arise when the reference data does not come from the same racial or ethnic group, and so these figures must be interpreted with caution. Several studies have been carried out on non-Caucasian populations to determine baseline norm values for these different racial groups. Such figures then allow direct comparison on a quantified basis between different racial groups.

Many different types of cephalometric analyses have been proposed. A number of the analyses are extremely elaborate and the relevance and usefulness of some of the measurements is obscure. Practical analysis should concentrate on features that have an immediate bearing on the clinical problem at hand and its treatment, and should be reproducible and valid.

When establishing reference standards for a population, the problem of patient selection arises. Since normal occlusion is not the usual finding in a random selection of a population group, the sample must have a degree of preselection to exclude obvious facial asymmetry, deformity and severe malocclusion. Each of the established cephalometric analyses is based on ideal or normal facial appearance and occlusion. They provide information which enables a classification, together with linear and angular measurements to be made to relate facial and dental structures horizontally and vertically. It is important to appreciate that these figures are to support a clinical diagnosis, not to replace it. The data from one particular analysis will provide basic information, but it should be supplemented with further measurements should the information not provide sufficient detail for the particular problem at hand. To judge a ‘normal’ appearance can be a rather subjective decision, beauty being in the eye of the beholder, but attempted to define facial normality as ‘that balance and harmony of proportions considered by the majority of us as pleasing in the human face’. In an attempt to quantify facial appearance many workers have developed profile analyses, all being based on studies of good faces, many including those whose facial appearance has achieved public acclaim, such as film and television personalities and beauty queens. Together with the cephalometric analysis it plays a vital role in making the assessment, diagnosis and treatment planning of individual cases less subjective.

Several orthodontic studies have been carried out on Middle Eastern communities and of these, only five have been specifically related to Saudi Arabia. On reviewing these papers,
only three involved the use of a cephalometric analysis in the results, the others using the somewhat empirical approach of using visual classification of the malocclusion with its inherent problems of reproducibility and validity. With the increasing provision of orthodontic care in Saudi Arabia, both with and without supportive oral maxillofacial surgery, the need for establishing baseline cephalometric data to aid diagnosis and treatment planning becomes paramount. The continued application of Caucasian norm values to Saudi Arabian patients cannot continue as the Middle Eastern facial form is entirely different.

It was with this problem in mind that the study was set up, to measure 100 Saudi Arabians with normal facial appearance and occlusion and to establish a baseline against which patients needing orthodontic or surgical treatment could be compared and contrasted.

Materials and Method
The material for this study was collected from the standardized lateral cephalometric radiographs of 100 adult patients who have never received any orthodontic treatment. These patients had presented for routine dental treatment at the Armed Forces Hospital in Riyadh and


Table 1

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Linear measurements

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<td>Length of posterior cranial base</td>
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<td>Length of mandibular corpus</td>
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<td>1APo</td>
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Table 2

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(After Dahlberg).
were chosen on the basis that they had been born in the Kingdom of Saudi Arabia, had a normal facial appearance and profile as defined in previous studies and a Class I skeletal and occlusal relationship, with well aligned and coordinated arches.

The records were obtained from 50 males, with an age range of 18–33 years, mean age 24.3 years; and 50 females with an age range 18–36 years, mean age 25.2 years. Adults were selected to ensure that any growth potential had been fully expressed and that the chances of any future facial and skeletal maturation were minimal. All measurements were taken by digitizing the radiographs directly on a Houston Digitizing Tablet, having all been taken with the teeth in normal occlusion. The points and planes studied are shown in Fig. 1, with the skeletal and dental parameters used identified in Table 1.

The error of the method using Dahlberg’s formula was obtained by redigitizing 30 cases at random, and is recorded in Table 2. These results show that the error is essentially that of landmark identification.

Results

The cephalometric angular and linear measurements of the male and female Saudi Arabian patients are given in Tables 3 and 4. These figures were based on the commonly used and accepted cephalometric parameters and were tested for significance using Student’s t test. They show a remarkable similarity between the male and female groups with the only significant differences occurring at less than the 5% level. The lower incisors of the female group were more proclined, which also accounted for the more acute intercanine Angle. Their lower and total facial heights were also reduced, as was the length of the mandibular corpus.

A comparison between the results of similar measurements of this report and other cephalometric studies is given in Table 5.

Discussion

When using cephalometric data clinically, it is important to compare the data of each individual patient to their own population and ethnic group values. One of the major problems has been how to establish normal reference standards for various population groups. Two main approaches have been made, either to use small samples but with very strict selection criteria, or to have a very large sample containing less rigidly selected groups. Investigations of the former type were based on small group studies. The frequently used Down’s analysis was based on 25 untreated adolescents with ideal occlusions, and Steiner’s original figures were based on the dentofacial measurements of one Hollywood starlet of his time! Down’s baseline reference was the Frankfort plane, Steiner’s was the S-N plane and Ricketts used a constructed plane based on a line between nasion and basion. More recent studies were based on much larger population samples and used commonly accepted planes of reference (Table 2), and as such tend to give a more accurate picture of the sample population as a whole. This seeming lack of consistency between both sample size and dentofacial parameters used in various investigations, serves only to highlight the need for further standardized cephalometric studies of the Saudi Arabian population to establish an adequate database.

The Bedouin, or Saudi nomads, are often considered true Arabs, or at least the descendants thereof. They make up approximately one-quarter of the population of the Kingdom of Saudi Arabia, the remainder showing quite marked variation due to regionalism, tribal autonomy and migration from neighbouring countries, Africa to the west, with Iran, Pakistan and India to the east. Despite this variation there is still an underlying ethnic homogeneity, but even combining the results of
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Shalhoub et al. and Sarhan & Nashashibi with those from this study, we are only scratching the surface in terms of establishing a Middle Eastern cephalometric standard.

Many analyses that have been used in the past have been either overelaborate or include parameters that are obscure and meaningless. To provide relevant information a practical cephalometric analysis should restrict itself to features which have a direct bearing on the clinical problems and its management. The parameters used in this study, Table 1, were developed from several different sources utilizing the most important features of each, to give an accurate, easily applied and reproducible composite analysis, which is highly suited to both orthodontic and oral maxillofacial diagnosis and treatment planning.

The male and female Saudi Arabian face shows an underlying ethnic trend towards bimaxillary protrusion, which is in agreement with the other Saudi studies and with the only other Middle Eastern cephalometric study from Iran. The similarity between the results of Shalhoub et al. and this present study are reassuring, as this independent study, although not using identical parameters, seems to come to similar results and conclusions regarding facial convexity. The study of Sarhan & Nashashibi, although useful, must be viewed with some caution as the sample group was exclusively male, between the ages of 9 and 12 years. By using such a young sample group, one that has yet to reach the pubertal growth spurt, the results obtained are intermediary, as further growth and facial maturity will continue to change the values well into the late teens and early twenties. Indeed, some workers consider that skeletal and dentoalveolar remodelling occur throughout life and that no linear or angular measurement is absolute.

The cephalometric values obtained in this study (Tables 3 and 4) are now used in this Orthodontic Department as an aid in the diagnosis and treatment planning of orthodontic and oral maxillofacial surgical cases for Saudi Arabian patients. It had been found that by applying Caucasian standards to the Middle Eastern face, the treatment results were producing Caucasianized Saudis, with incisors that appeared too upright and a very flat facial profile which was not supported by the high forehead, nose and everted lips characteristic of the Middle Eastern face. It was noticed that in some cases, both orthodontic and surgical, a degree of relapse towards a more procumbent dentoalveolar position was occurring, together with a more pleasing and obviously more stable soft tissue environment and function. With the adoption of the 'Saudi norm values', the treatment results to date seem to be more stable, and give a better facial balance and soft tissue function. These patients are being reviewed annually, and form part of a long-term programme to establish a Saudi database within the Orthodontic Department.

A comparison between the male and female values show the underlying trend towards bimaxillary protrusion in both sexes, but with a slightly greater anterior mandibular apical base displacement in the female group. The females also showed a reduced lower facial height, and so a reduced total facial height, and a shorter mandibular length as measured by GoPo and ArPo (Tables 3 and 4). Although these differences are statistically significant at the 5% level of confidence, they are essentially clinically insignificant in terms of diagnosis and treatment planning.

More significant differences are to be found when comparing the Saudi results with those from other racial groups. These figures are able to quantify the differences that are subjectively apparent between different racial groups. Table 5 shows a comparison with Caucasian, American Negroes, Japanese, Chinese and Iranian groups, using parameters common to each of the studies. The fact that in all of these studies only nine measurements were common to some, shows the problem of standardization of cephalometric measurements even within orthodontic and surgical studies.

Skeletally, the Saudis are similar to Caucasians in having a comparable degree of prognathism of both maxilla and mandible to cranial base, as measured by SNA and SNB. The dental bases are however more procumbent and it is this that is responsible for the bimaxillary protrusion which is the common feature of the Middle Eastern face. The appearance is not as severe as that of the American Negro and Chinese face because their skeletal bases are markedly protruded, which combined with the proclined incisors gives these races the characteristic facial appearance of full, rolled, often everted lips. In treatment terms this makes the correction of incisor malocclusion easier, as often the incisors merely need to be aligned and tipped distally, rather than retracted bodily as is often the case when treating American Negro bimaxillary protrusion cases.

Conclusions

With the increasing availability and demand for both orthodontic and maxillofacial surgical treatment, the limitations of applying Caucasian cephalometric standards to the diagnosis and treatment planning of Saudi patients was becoming very apparent.

It was felt that in order successfully to treat patients a Saudi cephalometric database should be established and expanded. This study has added
to values previously reported\(^{21}\) and now forms the basis for the assessment of Saudi patients at this hospital. The values are given in Tables 3 and 4, and it is hoped that other independent studies will be undertaken within the Kingdom to expand the database that has now been established. It is only with such information, that we can assess both our treatment successes and failures, in order to strive for clinical excellence in the diagnosis and subsequent treatment of our patients.

Acknowledgements

I would like to thank Maureen Burney and Linda Gray for their invaluable assistance in collating and sorting all the patients records and radiographs to enable this study to be undertaken.

References